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THE IMPROVEMENT OF THE ILLINOIS RIVER, looking toward the ultimate construction of a deep waterway from Chicago to the Mississippi River, is the object of a resolution now before the Committee of Waterways and Drainage of the Illinois Legislature. The resolution recounts that whereas the completion of the Chicago Drainage Canal will open up the most expensive part of such a waterway it is the policy of the state to secure the further completion of the waterway to the Mississippi River, and to this end the Federal Government is urged to remove the present dams in the Illinois River and otherwise to deepen and improve it to an extent suitable for navigation. This resolution is in direct line with the policy of the Illinois River Valley people in their recent legislation effecting the Chicago Drainage Canal, which it will be remembered bound the trustees in charge of that enterprise to build swing bridges over the channel and otherwise to recognize the waterway features of the work in all further constructions.

THE NEW ORLEANS DRAINAGE COMMISSION, as the result of an opinion delivered by City Attorney Gilmore, finds that it can obtain no further revenue from the Permanent Public Improvement Fund until 1899, and the proposed work of drainage is limited in consequence. There was, however, sufficient money in hand to complete work under way, including the building of Station No. 6 and the digging and cleaning of the canals leading to it. Major B. M. Harrod, Engineer of the Board, submitted a report upon proposed changes in location and upon the condition of the work generally.

THE WORK OF TRACK ELEVATION in the city of Chicago is receiving more attention at present than for some time past. Besides the work of the Chicago & Northwestern and the Pittsburg, Fort Wayne & Chicago railways, noted in Engineering News of May 20, the notorious 16th St. crossing has just been ordered abolished by the city council. This work will require the elevation of the tracks of the St. Charles Air Line and four other railways and the depression of the tracks of the Chicago & Western Indiana and Atchison, Topeka & Santa Fe railways, and will cost some $2,500,000. It is stated that the roads interested have signified their willingness to accept the ordinance and that the beginning of work may be expected at an early date. The character of the construction will resemble in a general way that of previous track elevation work in Chicago, which has been described in Engineering News of Aug. 20, 1896, and numerous previous issues. The 16th St. crossing has always been considered one of the most dangerous grade crossings in Chicago and the prospect of its early removal is unusually gratifying.

THE MOST SERIOUS RAILWAY ACCIDENT of the week, and that not very serious in itself, was a glancing collision at the South Ferry terminal station of the New York elevated railway, May 21. The Ninth Ave. and Sixth Ave. trains have each a single terminal track, on opposite sides of a platform, and outgoing Ninth Ave. trains have to foul the crossing for incoming Sixth Ave. trains. The switches and crossings are protected by interlocking plant and disk signals, but the engineman of an incoming Sixth Ave. train ran past the danger signal and the engine of this train struck the front edge of the third car of an outgoing Ninth Ave. train, which was crossing over to the uptown track. Nobody was badly hurt, but the few passengers were shaken up, and one was thrown down.

THE BROOKLYN DRY DOCK LEAKAGE has been reported upon by a special board of civil engineers. They found, at Dock No. 3, a large hole in front of the entrance to the dock, made originally by the disturbance of the sheet-piling by a dredge. Water was entering this hole and passing into the dock at the rate of about 10,000 gallons per minute, according to the press reports. The board hopes that the damage can be repaired by divers and that a coffer dam will not be necessary; but they estimate the cost of the repairs at $20,000, a sum which will require a direct appropriation by Congress.

AN EMERGENCY CASE OF LONG-DISTANCE electric transmission took place between Canton and Massillon, O., on May 19. The two cities are about eight miles apart and their street railway systems are owned by the same company. The chimney of the plant at Canton was being repaired and during the day it was out of use the Canton railway was operated by current generated in Massillon. The two lines had been built at random and for a distance of six miles the current (520 volts) traversed a single No. 000 wire. The extreme distance to which the current was carried was about 11½ miles. The number of cars in Canton was reduced to about one-third of the usual number. The arrangement worked all right except when a heavy interurban car was ascending a hill between the cities, when it would consume all the power and the cars in Canton would almost stop.

A STEEL ROADWAY FOR HIGHWAYS is to be built at the Nashville Centennial by Gen. Roy Stone, of the Office of Road Inquiry, at Washington, D. C. A roadway 300 ft. long is to be thus equipped as an object lesson.

THE BLACKWELL TUNNEL, under the Thames, at London, was formally opened to traffic by the Prince of Wales on May 22.

THE NEW PUBLIC LIBRARY BUILDING FOR NEW York city has been authorized by the bill passed by the Legislature and approved by the Governor. The estimated cost of the library building is $1,700,000, and it will occupy the site of the reservoir at 42d St. and Fifth Ave. The Trustees of the New York Public Library and the Astor, Lenox and Tilden Foundations have appointed a committee to prepare plans, with Mr. John S. Kennedy as Chairman and Mr. George L. Rives as Secretary. When the plans are approved the building will be constructed under the Commissioners of Public Parks. The committee proposes to obtain plans by two consecutive competitions; an open competition for sketches only, and a restricted paid competition. Director John S. Billings, Bernard R. Green, engineer in charge at the Congressional Library, and Prof. Ware, of Columbia College, will be the judges in the preliminary competition. The second competition will be decided by a committee of seven, made up of three members of the Board of Trustees, the Director and three practicing architects selected by the competitors. The proposed building will stand on a lot 482 by 455 ft. square, and the price of $1,700,000 is to be exclusive of the heating, lighting, ventilation, furniture, book-stacks, shelving, architects' fees and the cost of removing the reservoir. The building must be thoroughly fireproof, and have an ultimate capacity of 4,000,000 volumes. All New York architects are invited to compete, and for the twelve most meritorious sketches selected by the judges, $400 each will be paid. From these twelve six men will be chosen for the second competition and $800 will be paid to each for the estimated cost of the drawings required. From these six, at least three sets of plans will be selected and sent to the Trustees, with comments on each for their guidance, and the Trustees will then send one of these to the Board of Estimate and Apportionment for its approval, subject to such changes as may be afterwards deemed advisable, and the Trustees will recommend the author of this last plan as the architect of the building. The Trustees may also appoint an engineer to superintend the work. Full details of the scale and class of drawings required, the general dimensions, floor area, etc., can be obtained from the Secretary of the Trustees Committee, Mr. Geo. L. Rives, 32 Nassau St., New York city.

TO DETERMINE THE SEASON OF NAVIGATION on Hudson Bay is the object of a special expedition just dispatched from St. Johns, Newfoundland, by the Canadian government. The expedition is in charge of Commander Wakeham, of the Dominion Department of Marine and Fisheries, and he will have with him, according to the press dispatches, representatives of the Dominion and Manitoba governments, and Captain Bourke, R. N., who represents British capitalists. The expedition will last seven months and its members will thoroughly investigate the nature and length of the open season on Hudson Bay and its adaptability as the eastern terminus of a railway line intended to connect the grain fields of Manitoba with a line of steamers from Hudson Bay to Europe. This scheme will be recognized as the Winnipeg-Hudson Bay short cut grain route to Europe which first came into prominence in 1880 by securing from the government a subsidy of 10,000 acres of land per mile of completed road to aid in building a 500-mile line from Winnipeg, Manitoba, to Hudson Bay. On the strength of this subsidy the money was secured to build 40 miles of the line northeast from Winnipeg. For some years the promoters of the scheme have been occupied alternately in soliciting further government aid and in trying to interest English capital in the enterprise. The government has twice increased its first subsidy, but in 1895 was again solicited to guarantee the interest on a $15,000,000 loan. This it refused to do outright, but compromised by agreeing to send the present expedition to investigate the possibilities for the successful navigation of Hudson Bay by grain steamers. In 1884 a similar expedition explored the country for the same purpose and reported against the enterprise.

ARMOR PLATE for battle ships may cost as much as $400 per ton, according to the unanimous recommendation of the Senate Naval Committee.

CONTRACTS FOR BRIDGES ACROSS THE CHICAGO Drainage Canal will, it is stated, be let so as to have the bridge work of the Sanitary District completed during the present season. Altogether there will be 14 bridges to be built, of which five will be railway bridges and nine highway bridges. Of the railway bridges, four will be for two tracks and one, located at Campbell Ave. and 31st St., in Chicago, will carry eight tracks. This last structure will be 400 ft. 5 ins. long and 120 ft. wide and will weigh 7,000,000 lbs. It will be constructed of medium steel and operated by electric power. Its total cost, without the turning machinery, is estimated as $569,000. All the bridges will be swing bridges, the highway structures of the "bob-tail" type, with the pivot pier at one side of the channel, but for the present the operating machinery will not be installed, as the bridges will not be required to swing until the canal is used for navigation. The total cost of the bridge work to be done by the Sanitary District is estimated at $1,800,000.

THE ATLANTIC AVE. IMPROVEMENT in Brooklyn, N. Y., seems likely to be carried out. Governor Black having signed the bill for the work, which includes removing the Long Island R. R. tracks from the surface of the avenue to an underground line, and building a tunnel to carry this line under the East River to a station near Cortlandt St., in New York city. The Long Island R. R. is said to be anxious to have work started as soon as possible, and the consulting engineer, Mr. C. E. Jacobs, is now on his way back from Europe, where he has been to inspect other underground lines and tunnels.

THE PITTSBURG WATER FILTRATION EXPERIments are to be started immediately, work already having been begun on a small subsiding reservoir and two small filter beds. The reservoir and filter beds will adjoin each other, and will have masonry walls and a concrete bottom. The capacity of the reservoir will be about 34,000 gallons. Each filter bed will have an area of 290 sq. ft., or 0.00665 acre. The commission has an available fund of some $20,000 or $25,000 to be used in the experiments. It is composed of eleven members, as follows: Robert Pitcairn, Chairman; W. J. Holland, Chancellor of the Western University; Jas. H. Bailey, Dr. J. Guy McCondlers, Dr. Jas. R. Vincent, E. M. Bigelow, M. Am. Soc. C. E., Director of Public Works; G. L. Holliday, S. D. Warmcastle, William McConway, H. P. Ford, Mayor of Pittsburg, and William Flinn. Mr. Allen Hazen, St. Paul Building, New York city, is Consulting Engineer; Mr. Morris Knowles, Assoc. M. Am. Soc. C. E., formerly Assistant Engineer to the Metropolitan Water Board, and a member of the water board of Lawrence, Mass., is Resident Engineer, and Dr. Walter Riddle, of Pittsburg, is chemist. The bacteriologist has not been appointed. Mr. Pitcairn is reported as stating that various systems other than slow sand filtration will be tried during the year the commission proposes to devote to the work.

ALTERNATE PROPOSITIONS for 48-in. cast-iron and 50-in. steel pipe are to be received soon at Minneapolis, Minn. There will be 15,800 ft. of ordinary pipe, and four lines of 36-in. submerged cast-iron pipe, each about 750 ft. long. The bids may be on either the pipe alone, or pipe and pipe-laying combined. Bids will also be invited on specials and gates for the pipe lines. The work is being done to connect the new reservoir with the pumping station and distribution system. Mr. F. W. Cappelen, M. Am. Soc. C. E., is City Engineer.

SOME RECENT EXAMPLES OF WATER TOWER CONSTRUCTION.

The accompanying engravings show three unusually interesting and in some respects structurally noteworthy designs for water towers, which have been constructed by the U. S. Wind Engine & Pump Co., of Batavia, Ill., during the past year. These towers are located at Warren, Ill., Dwight, Ill., and Lexington, Ky., respectively; the tower at Warren, Ill., being for the public water supply of the town, while the two others are for private water supplies for the large country places of Mr. J. R. Oughton, of Dwight, Ill., and Mr. Frank Sturges, of Chicago, Ill. At Warren, Ill., the controlling conditions were utility and economy, no extra expense being warranted for ornamentation or architectural embellishment of any character, and accordingly the design presents simply the utilitarian side of water tower construction. At Dwight and Lexington, however, the conditions were different, a handsome appearance being required of the structures as well as utility for their purpose, and, further, the tower at Dwight required a rather unique architectural treatment to secure its harmony with the general architectural scheme of the neighboring residence and farm buildings.

Fig. 1.—Masonry Water Tower 102-Ft. High for Town Water Supply at Warren, Ill.

Turning now to a brief consideration of the individual structures, it will be seen that Fig. 1 shows the masonry tower and adjoining power house for the town water supply of Warren, Ill. This tower is 102 ft. high from the water table to the bottom of the tank. The masonry is founded on solid rock about 12 ft. or 13 ft. below the water table. At the level of the water table the walls are 4 ft. thick, and from this they decrease with a uniform taper to a thickness of 2 ft. at the top. The masonry is of limestone laid in cement mortar. The tank is made of red Louisiana cypress, and is 24 ft. high and 21 ft. in diameter, with a capacity of 2,000 gallons. The standpipe which supplies the water to the mains is 10 ins. in diameter and is connected with the bottom of the tank with an expansion joint and a balance float valve. This valve automatically shuts off the water when the tank is full.

Water is pumped to the tower from a deep well located in the brick power house about 60 ft. away. This well is about 800 ft. deep, with a 10-in. casing, and is pumped with a 7¾-in. artesian well brass cylinder, which is attached to the lower end of a drop pipe 8 ins. in diameter and 150 ft. long. The plunger is worked by a 3½-in. shaved wood rod with oil couplings. The steam cylinder is 12 ins. in diameter and has a 36-in. stroke. The water is lifted from the well to the top of the tower without rehandling. Eventually the water will be discharged into a reservoir where it will be handled by another pump for fire service, but in the meantime a very fair fire pressure is had direct from the tank, which is elevated some 40 to 50 ft. above the larger part of the town.

The tower at Dwight, Ill., is a combination water, windmill and observation tower, and was designed by Mr. Julian Barnes, Architect, of Chicago, Ill. Briefly described, the tower is a steel framework covered in, shingled with slate and otherwise architecturally embellished, as shown by the engraving. The bottom of the tank is 70 ft. above the ground and just above the observation floor, and the windmill is 90 ft. above the ground. From the observation floor access is had to the windmill by means of a vertical cylindrical opening through the center of the tank. The tank has a capacity of 4,000 gallons. This central passageway is an unique feature and its object was, of course, to preserve the symmetry of the tower by avoiding the usual outside ladder. The wind engine is of the Halliday type and it operates a deep well cylinder placed about 300 ft. below the wheel.

The third water tower illustrated was built to supply water for domestic and farm and conservatory uses on the farm of Mr. Frank Sturges, which is located about six miles out of Lexington, Ky. The masonry tower was constructed entirely of white marble quarried on the farm of the owner. Not allowing for the cost of the marble, anything except labor, the tower cost complete about $6,000. The tank is located in the upper part of the tower and is supplied with water from a deep well, pumped by the wind engine shown to the left of the tower. The appearance of the tower would have been greatly improved if the roof had been either omitted or made to project over the tower line, the battlements in the latter case giving way to a cornice.

A PLAN FOR IMPROVING THE WATER SUPPLY OF A PORTION OF PHILADELPHIA.

Mr. Jno. C. Trautwine, Jr., Assoc. Am. Soc. C. E., head of the Philadelphia Water Department, has recently prepared a plan for improving the water supply of that part of the city which lies west of the Schuylkill River, and which at present suffers most seriously from the impurity of the present supply. We present below an outline of the plan presented by Mr. Trautwine, and have commented upon it in our editorial columns:

West Philadelphia, or that portion of Philadelphia lying west of the Schuylkill River and comprising the 24th, 27th and 34th wards, is suffering more than other sections of the city from a deficient and otherwise defective water supply. The population is estimated at about 130,000, and the daily consumption, as deduced from the plunger displacements of the pumps, is from 25,000,000 to 30,000,000 gallons, or from 192 to 231 gallons per capita. The capacity of the four Worthington pumps supplying the district is nominally 38,000,000 gallons daily, but is limited, by insufficiency of boiler capacity, to about 28,000,000. There is but one reservoir, with a total capacity of 40,000,000 gallons, but all this could not properly be drawn off, and there is, at best, only a bare 24 hours' storage capacity for emergencies.

The district is, therefore, practically on direct pumpage. The pumps must run without intermission, although the river water is heavily charged with mud after every rain storm, and is often literally black with coal dust from the anthracite coal regions, and little or no advantage is gained by the short term of subsidence possible in the reservoir.

So serious has the evil become that the citizens have been holding meetings for agitation and for the study of the situation, and various schemes have been proposed for its amelioration.

For at least two years the Department of Public Works has been asking for an appropriation for the purpose of increasing the storage capacity, and has recommended that the district be connected with the main system on the east side of the Schuylkill, in order that either side may, in emergency, come to the aid of the other.

Both of these propositions figure among those recently brought forward. The amounts suggested for the new reservoir range from $250,000 to $1,000,000.

The Chief of the Bureau of Water now recommends a plan involving (1) the stoppage of the inordinate waste of water by the application of a meter to every supply in the district, and (2) the construction of a sand filter-bed, of capacity sufficient for the purification of the reduced quantity which would then be required. For the construction of the filter-bed a very eligible site belonging to the city, close to the pumping station and at the level of the river, is available.

Judging from the experience of other places, it is safe to expect that the use of meters, as proposed, will, by simply cutting off utterly useless waste, reduce the consumption one-half, but, allowing for a reduction of only one-third, and for a filtration rate of only 2,000,000 gallons per acre per day, it is roughly estimated that a sufficient filter-bed can be constructed for $500,000 or less, while the metering of the entire supply may cost about $300,000 more.

As is usual in places where meters are practically unknown, there is considerable local prejudice against their use, but it is hoped that this may give way in view of the advantages of metering.

In the present case these advantages are (1) that the effective capacity of the present pumping station, reservoir and pumping supply mains will be greatly increased, if not doubled, and the necessity for increasing these postponed for years; (2) that the cost of the filter-bed will be not more than one-half or two-thirds of what would be needed for the present excessive supply, and (3) that all the expenses of pumping and filtering will be greatly reduced.

It is considered unnecessary at present to provide for future increase of the service, for the plant here suggested is capable of gradual extension as occasion may require.

Fig. 2.—Steel and Slate Water Tower for Country House near Dwight, Ill.
Julian Barnes, Chicago, Ill., Architect.

and the experience gained in its operation can be turned to account in the erection of any extensions that may be required in the future.

As the filter plant would be located upon ground belonging to the city, there would be no expenditure for real estate; as the filter proposed is of the well-known sand-bed type, there would be no payments of royalties, and, as no alum would be required, the objections of those who oppose all use of alum would be avoided. Furthermore, sand-bed filters having had general and successful application, there would be only so much of "experiment" as there must be in applying any filtration plant under untried conditions.

We understand that the finance committee of the councils has agreed to recommend a $1,000,000 loan for an enlargement of the present reservoir, additional pumps and a filter plant for West Philadelphia

THE PORT ARTHUR AND SABINE PASS CANAL which the Kansas City, Pittsburg & Gulf Ry. Co. propose to excavate as an outlet to the Gulf, was commenced on May 11 by setting a large dredge at work.

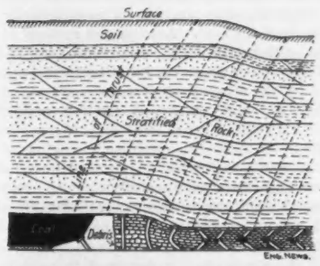
THE SUBSIDENCE OF RAILWAY TRACKS AND OTHER STRUCTURES LOCATED OVER MINE EXCAVATIONS.

By John Keay*.

As an inspector of mines my attention has several times been called by railway companies to subsidences of tracks caused by a coal seam underneath having been removed in whole or part by mining. There can be no general rule expressed as to what effect the mining of a coal seam will have on the surface. This depends largely on the depth from the surface to the coal seam, the thickness of the coal seam, the nature of the strata between the coal seam and the surface, the stratum underlying the coal, the presence of drift or silt above the stratified rocks and the method of working the mine. Much of the knowledge that can be obtained on this subject is, therefore, empirical, resting on the experience obtained in different localities.

There are two general methods of mining coal, "long-wall" and "room-and-pillar." All other methods may be considered a modification of one or the other of these, or a combination of both. In the long-wall method all of the coal in the seam is taken out, and with the exception of the passageways its place is filled with loose material taken from the roof of the passageways and from the undermining. In room and pillar workings, chambers or rooms are driven from passageways or entries in the solid coal, and pillars of unmined coal are left between the rooms to support the roof. Sometimes these pillars are mined out after the rooms have been driven the required distance. The timbers placed in mines to support the roof give no permanent support to the surface. Their purpose is merely to support the roof as the workings advance. The walls of debris, with which most of the excavated space in long-wall workings is filled, give no support to the surface until the debris is compressed by the weight of the overlying strata. In mining parlance every disturbance of the roof caused by mining is called a "fall," a "cave in" or a "squeeze." The term "cave in" is used when a fall occurs over a small area, breaking the supporting timbers and closing a room or passageway, the pillars on each side giving sufficient support to localize the fall. A "squeeze" is so called when the weight of the overlying strata is breaking the pillars or crushing them into the soft underlying stratum. When commenced it usually continues until the roof and the bottom of the part of the mine affected come together.

Long-wall working is generally confined to seams less than 5 ft. in thickness, which have a plastic roof, usually of shale, which bends as the weight of the strata rests upon it. A continuous squeeze follows within a few feet of the advancing working face. All of the coal, except a pillar around the



Longitudinal Section through Long-Wall Workings Showing Surface Subsidence.

shaft is taken out. The debris with which the excavated space, except that necessary for passageways, is filled is usually compressed by the weight of the overlying strata to about one-half of the space that it occupied when first put in. The direction of the thrust is not exactly vertical, being inclined over the excavated area towards the face. Where there is not more than 100 ft. of strata above the seam worked, there is a continuous depression of the surface as the workings advance, usually somewhat less than half the thickness of the seam. Generally no surface subsidence occurs when but one seam of coal overlaid by 800 feet of strata has been mined, and no subsidence of the surface may occur when the seam is at much less depth. It is, however, important to know that no material subsidence of the surface occurs at a long-wall mine, other than that which immediately follows the advancing working face, so that after a mine is abandoned, which has been worked by this method, normally heavy structures may be erected over the excavated area, and railways may be graded over such workings after the mine has been abandoned, without fear of any further sinking of the surface, unless the mine was very shallow or had a thin stratified cover, overlaid by a heavy covering of quicksand or drift. In the latter case a caving of one of the passageways may cause a running of the quicksand or drift into the mine.

Seams of coal over 5 ft. thick are generally worked by the room-and-pillar method, or some modification thereof. Rooms or chambers from 14 to 60 ft. in width are opened from the passageways or entries. It is usually intended that the weight of the overlying strata shall not rest on the working face of the coal. The width of the pillars between the rooms and entries is subject to

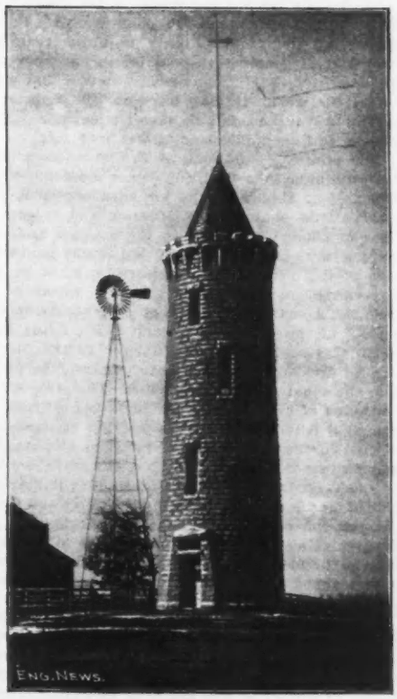


Fig. 3. Marble Water Tower for Country House Near Lexington, Ky.

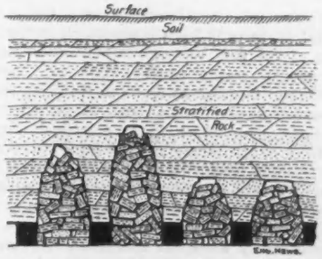
local conditions. When the roof is reasonably soft and there is no strong stratum, such as a thick limestone or sandstone above the seam of coal, one-third or less of the coal is left unmined to support the roof. When there is a thick covering of stratified rocks and the rooms cave in singly without crushing the pillar that is left between them, there is usually no sinking of the surface. When the rooms and entries are driven so that the pillars may be withdrawn, a somewhat similar condition in relation to the surface to that obtaining at a working long-wall face accompanies the withdrawal of each pillar. A thick stratum of strong limestone or sandstone above a seam of coal is conducive to a squeeze over a large area, and is often accompanied by a sinking of the surface. Wide pillars are required to support the roof and surface where such a stratum exists. The conditions inducing a squeeze are intensified by a soft under stratum, especially so if water is present. Wide pillars are required to support the roof where such conditions obtain. The roof under such circumstances does not usually cave and arch in each room. The weight over a large area rests on the pillars and crushes them or sinks them into the underlying stratum, causing the strata above to sink and the under stratum to heave until the roof and bottom come together. Occasionally a thin stratum of limestone or other strong stratum, which forms the roof, or is near to it, thickens so that

Longitudinal Section Through Room and Pillar Workings Showing Surface Depression Caused by a Squeeze.

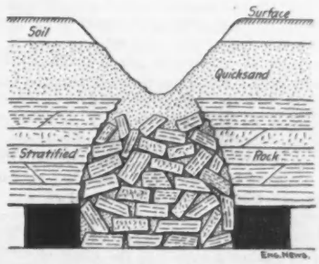
each room does not cave in singly, and a squeeze involving a subsidence of the surface takes place where none was expected.

Where the coal has been mined under a strong roof, without sufficient pillars having been left, there always exists the probability of the commencement of a squeeze and sinking of the surface without any practical means of prevention. In mining practice, when a squeeze has commenced and it is desired to continue the mine workings beyond the area involved, it is customary to localize the squeeze by withdrawing whatever pillars can be safely taken out near the exterior limits of the squeeze, so as to allow the overlying strata to shear along the margin of the removed pillars and the area included in the squeeze to settle, and thus prevent the squeeze from extending to the adjacent pillars towards which it was advancing, and crushing them by adding to the weight of the strata lying vertically above them the weight of the strata above the pillars that are being crushed by the squeeze.

The presence of a covering of drift or silt over the stratified rocks is often a contributing factor in surface subsidences. Drift is usually deposited on an uneven surface of rock that has been subjected to glacial planing. The caving of a room or passageway through the stratified rocks may



Longitudinal Section Through Room and Pillar Workings Showing Single Rooms Caved in.



Longitudinal Section through Caved-in Room with Thin Stratified Covering Overlaid with Quicksand.

cause a running of the drift or silt into the mine and leave a funnel-shaped cavity at the surface, the size of which depends upon the thickness and natural slope of the drift material or silt, the area of the opening of the stratified rocks at the bottom of the drift; the thickness of the coal

*Inspector of Mines, State of Illinois, 1031 Reservoir St., Springfield, Ill.

seam that has been mined and the extent and area of the underground passageways and excavations. An occurrence of this nature, where the stratified shale was thin and covered with quicksand, and the surface subsidence due to long-wall working was filled with water, happened in 1883 at a mine near Braidwood, Ill., by which 69 miners were drowned. In 1885, at a mine of the Susquehanna Coal Company, Nanticoke, Pa., a room located beneath the culm bank was driven into a body of drift, and so sudden was the irruption of drift and culm into the mine that 26 miners lost their lives. Occasionally "pot holes" filled with drift material, principally rounded stones, are encountered in mine workings. An instance of this kind occurred in the main entry of the Streator Coal Co., Streator, Ill. Frequently a seam of coal is cut out for some distance by a sand bar, which, when met with, always presents the probability of a sinking of the surface until the running of the sand is controlled.

The line of pressure between the roof and bottom of a seam is at right angles to the plane of stratification. When the roof is broken the tendency of the cavity is to assume the form of a paraboloid, the height being in inverse proportion to the transverse strength of the different layers of strata. The vertical axis may at any time be increased by further caving of the base and the disintegration or fracture of the layers of the inner surface. All possible conditions relating to the surface may obtain at metalliferous mines, the general practice being in proportion to the value of the deposit to substitute for the pillars the artificial support given by the different methods of timbering. A frequent cause of litigation has been the subsidence of the surface, owing to the extraction of salt by the solvent action of water.

The following legal decisions and principles relating to surface support have been established:

There may be a severance of the mineral estate from the surface estate. Where there has been no severance of the mineral estate from the surface estate the possession of the minerals remains with the owner of the surface. Where there has been a severance of the mineral estate from the surface estate, if the law be not controlled by the conveyance, the owner of the mineral estate owes a servitude to the superincumbent estate of sufficient supports. Contract may devote the whole minerals to the enjoyment of the purchaser without support if the parties choose. The right to support of the surface may be waived in the conveyance but must be expressed in apt words. If, in addition to severing the coal from the surface by a sale, the owner releases his vendee and the underlying estate from surface support, the release is binding upon him and those taking title from him, but it cannot bind the state or its grantee. The right of eminent domain cannot be abridged or defeated by the contracts between private owners, or by the release of the owner of the surface. An entry by the state upon the surface is an entry upon the subadjacent strata so far as they are necessary to support the surface for the purposes of canal, railroad, pipe line or other structure to be built thereon. The grantee may insist upon the full measure of support which the law gives him, but it does not follow that he must do so because he can; he may release the owner from so much of the burden which his entry imposes, as is not necessary for the security of the undertaking.

It is not generally understood by owners of mines, nor by attorneys, that the servitude of surface support rests with the owner of a mine. In many of the conveyances of mining rights, usually drawn up by attorneys, much emphasis is given to working the mine in a workmanlike manner, and from this the inference is drawn that when the mine is so worked the duty of surface support ends. Recently, where a subsidence of the tracks of a railway came to my notice, the mine owner excused himself from blame by stating that the persons who conveyed the right of way to the railway company did not suppose that they had conveyed the strata underneath, and that the vendors of the mining rights of the tract to be worked at the mine had included the coal underneath the right of way of the railway, and that he had paid for such acreage. An attorney on consulting "The Law Relating to the Mining of Coal in Pennsylvania," which is a collection of the constitutional provisions, statutes and decisions relating to the mining of coal in that state, by Alfred B. Weimer, of the Philadelphia bar, would have no difficulty, before any court, in maintaining the principles relating to surface support, which have largely been established by eminent authority in Great Britain and accepted by the courts of Pennsylvania. So far, in other states, simply the question of mining coal not owned by the mine operator has arisen, and, as in Illinois, the value of coal at the surface that was improperly removed has been awarded as damages.

The legal regulations concerning the operations at coal mines usually provide that maps of the mine workings shall be made and a copy open for public inspection be forwarded to the mine inspector. In some states the provisions relating to the accuracy of mine maps are very insufficient, whilst in other states, if the mine inspector believes a map to be inaccurate, he is empowered to cause a test survey to be made, the expense of which shall be borne by the mine operator if the map is found to be incorrect, and by the state if the map is found to be accurate.

The legal regulations relating to the operating of mines in Prussia are issued by the mining boards or courts of the different mining districts, and generally require that the owner of a mining concession, previous to the opening of a mine, shall submit a project of the workings, which must be approved by the mining board of the district before mining operations are commenced. Before approving the project, it is required that the board shall consider the strata, the number and thickness of the different seams of coal and what effect the workings may have on the surface, so as to prevent as far as possible surface subsidences and accumulations of water therein.

The mining regulations of France require that, before a mine is opened, the owner must deliver to the prefect a plan of the intended openings and excavations, showing the situation and objects of the workings in relation to the surface and adjoining mines. Plans of any important modification of the original plan of working must be delivered before any change in the workings is made. A map must be kept and regularly extended of the workings of each seam, made to a horizontal scale of one millimeter to the meter, and be divided by lines oriented to the true north into the squares of one decimeter. The map of the workings of each seam must show the altitude of principal points, such as the position of the seam of coal in the shaft and the junction of passageways in the workings. A map of the surface must be made on transparent paper, so that it may be placed on the maps of the mine workings and show the relation of objects on the surface to the underground workings. The owner of a mine must inform the prefect one month before the workings have reached a roadway, a railway, or a boundary of the concession.

It is required by the mining laws of Saxony that the owner of a mine shall dispense with the services of any technical official or manager who loses his qualifications, disregards the life and health of employes, the safety of adjoining mines, or the required support of the surface.

The United States Mining Laws relate principally to the establishment of patents to mining claims. The mining laws of the different states have been enacted to provide for the health and safety of persons employed in and about mines. They contain no provisions regarding the working of mines in relation to the support of the surface.

After the mine workings under a right of way have for some time been abandoned, owing to the caving of the roof and accumulations of dangerous gases or water, there exists no means of ascertaining to what extent the right of way has been undermined, except that furnished by the mine maps, some of which are accurate; many are not. Most of the larger mining firms employ competent mining engineers. In some of the larger mining districts, where the mines are aggregated, mine surveyors have established offices, and usually make reliable maps. Where extensive areas are underlaid by workable coal seams regularly deposited at similar depths from the surface, the mines are often widely separated and are located at towns already established along the line of railroad, and where the coal seam is thin or irregularly deposited and used chiefly for local consumption, the mine maps, when made, are often the work of a surveyor who does not have sufficient practice in mine surveying to acquaint himself with the essentials required for accuracy in such work, or the map is often the work of a mine foreman who has not acquired the necessary knowledge, or possesses the requisite instruments to make a correct mine survey.

An instance occurs to my recollection, where at considerable detriment to the mine workings, a pillar of coal was left to support the approach and abutment of a large steel railway bridge. It was afterwards found that the pillar was not under or near the approach or abutment. Some old English text books on mining that yet possess value in relation to the ventilation of mines, teach how to survey mines by magnetic courses and to level with the lid of the compass box.

The manner of approaching abandoned mine workings, supposed to contain water, of which no maps exist, or the maps are believed to be inaccurate, is now a very serious matter in some mining regions. The report of a recent accident at a mine in England, by which a large number of men were drowned by an irruption of water from an abandoned mine, contained the statement that the maps of the abandoned mine were found to be incorrect. At present the slowing of trains over part of a line that has subsided without warning is an occasional occurrence. Hereafter there may be derailments on the surface that is to-day being undermined.

When the seam or seams of coal to be worked are regularly deposited below the level of the railway and the surface is even, the first mines opened are generally located on a siding near to and parallel with the railway. When the coal is mined along the line of the railway spurs are built and other mines opened on them. Usually a shaft is sunk near the railway, a pillar of coal is left around the shaft and the work of developing the mine and exploiting the seam proceeds with little or no regard to the support of the surface. Formulas relating to the size and strength of mine pillars to have any value must be purely the result of local observation and experience, and apply only where similar conditions of strata and the same plane of stratification exists. The Mines Regulation Chapter of Nova Scotia provides that no submarine seam of coal or other stratified deposit shall be wrought under a less cover of less than 180 ft. of solid measures, though the owner of any such area may drive passageways to win the mineral to be wrought under a less cover than 180 ft., but not under less than 100 ft. of solid measures. Where there is less than 500 feet of solid measures overlying the seam or stratified deposit wrought, the workings of such submarine area should be laid off in districts of an area not greater than one-half of one square mile, and the barrier enclosing each separate district shall not be less than 30 yds. wide, and shall not be pierced by more than three passageways having a sectional area not greater than 6×6 ft. A proposed system of working the mineral in each submarine area shall, before work is commenced, be submitted to and approved by the mine inspector, and no change shall be made in such approved system without the written sanction of the inspector. At a recent examination held in the anthracite region of Pennsylvania for certificates of competency for mine foremen, the examiners submitted to the candidates a question relating to the proper size of pillar to be left around a shaft. The answer published by the examiners as being correct was that the square root of twenty times the depth of the shaft in feet is equal to the radius of the coal pillar that should be left to support the shaft.

Though the duty of leaving support for the surface rests primarily with the operator of a mine, the owners of the railway on which the mine is located have far more interest in the stability of the surface than the owner of the mine. At the time of opening a mine, the product of which is to be shipped by rail there is usually much work to be done at the mine by the engineers of the railway company, such as the location of the necessary sidings. If the seam to be worked is below the level of the railway, it is then advisable that the officers of the railroad should require that the mine operator present for examination a plan of the projected workings of the mine, in relation to the support of the right of way of the railway, and

satisfy themselves that a competent person is directing the course of the workings that are near the right of way; or the railway company should for its own security occasionally examine and survey any mine workings that are contiguous to the right of way. The workings of mines that are opened by shaft are usually connected with the surface lines by weighted wires suspended in the shaft or shafts and the position of all points is referred to an initial point on a base line measured on the surface, preferably along a railway if it passes near the shaft in a right line.

THE SIMPLON TUNNEL.

In the "Revue Generale des Chemins de Fer," for November, 1896, M. Jules Michel presents the latest project for tunneling the Simplon, and treats of the present status of the enterprise as follows:

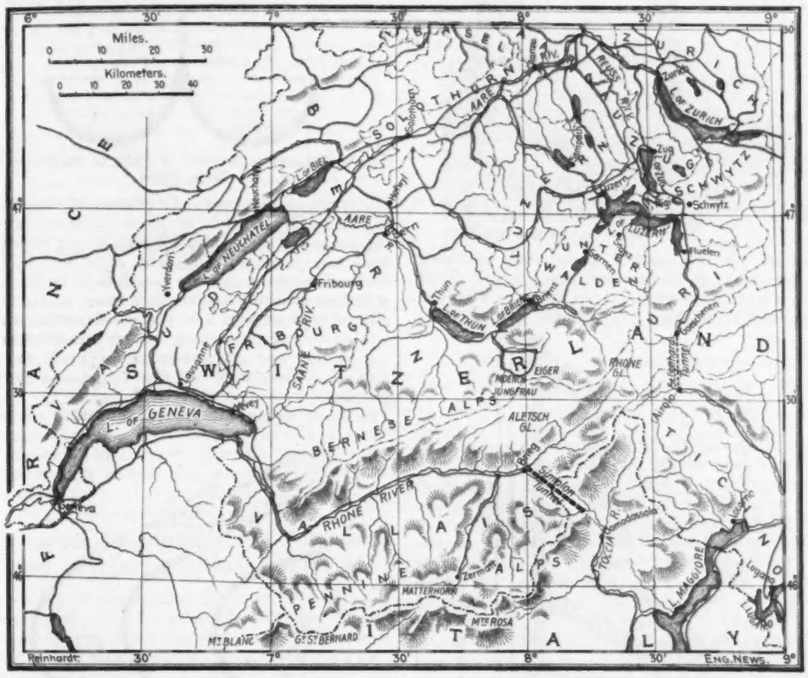


FIG. 1.—MAP SHOWING RELATIVE LOCATION OF THE ST. GOTHARD AND THE PROPOSED SIMPLON TUNNELS.

On May 29, 1896, the Italian government presented to the Chamber of Deputies for its ratification the treaty made with the Swiss government, on Nov. 25, 1895, relating to the piercing of the Simplon. The Italian government had previously, on Feb. 22, 1896, entered into an agreement with the Jura-Simplon Ry. Co., of Switzerland, for the concession and building of a railway between the Italian frontier and the mouth of the proposed Simplon tunnel at Isella. By this convention the Italian government was obligated to build a connecting railway between Domo d'Ossola and Isella, and it granted to the Jura-Simplon Ry. Co. the right to operate a stipulated portion of the great tunnel for 99 years. On the expiration of the concession or in case of redemption, the Jura-Simplon Co. was to be paid the whole cost of construction. This company had already obtained from the Swiss Federal government a concession for a line between Brigue and the Italian frontier, and, on June 11, 1896, this concession was presented to the Swiss Federal Chamber for approval. But on neither side of the Alps have the legislative powers as yet officially acted upon the propositions placed before them.

The project for tunneling the Simplon has, however, passed out of the diplomatic stage, prolonged over nearly half a century, and it is now open for engineering discussion and conscientious study. These studies include the interesting problems of geological formation, subterranean heat and the means of overcoming it, and the utilization of the natural sources of power provided by streams near the portals. The tunnel as now projected is to have a total length of 64,718 ft. or 12.2 miles.

Commencing in 1857 many projects have been submitted for tunneling this range of the Alps; but the present and what is believed to be the final plan was advanced by the Jura-Simplon Ry. Co., which, on Sept. 20, 1893, made a contract with Brandt, Brandau & Co., of Hamburg, to construct a single track tunnel, 12.2 miles long, terminating at Isella. This plan was submitted, by an arrangement with the Swiss and Italian governments, to a commision of experts, made up of Mr. Colombo, an engineer of Milan; Francis Fox, M. Inst. C. E., of London, and Mr. Wagner, of Vienna, State Inspector of Railways and formerly one of the engineers of the Ariberg tunnel.

The novel feature in this new project was the system of construction providing for the piercing of a secondary gallery, parallel to the principal gallery and 17 m., or 55.75 ft. from it. This secondary gallery was to be used in draining off water and to convey air and cold water under pressure to the working face. Air compressed up to 100 atmospheres was to be employed for ventilating the working chambers and for operating the drills and machines. Whenever the conditions of traffic would require it this auxiliary gallery could be enlarged for a second track. With the Brandt drills, used at Ariberg and in the Caucasus, advances of 18.37 to 24.20 ft. in 24 hours are recorded, and upon this basis it was estimated that the Simplon tunnel could be completed in six years. By the powerful system of ventilation proposed, it was believed that the temperature at the working face would not exceed 25° C., or 77° Fahr., while that in the St. Gothard tunnel touched 31° C., or 87° Fahr., and there was much illness among the workmen from the heat.

The map here produced shows the Simplon Range between Brigue and Domo d'Ossola, with the new line laid down upon it and cutting the frontier nearly at right angles, to satisfy diplomatic requirements. The length of the tunnel will be 19,731 m., or 12.2 miles; and the north, or Swiss entrance is 2,254 ft. above the sea; the summit at the center is 2,313 ft. above, and the south portal is 2,079 ft. above the same level. The mean thickness of the rock above the axis of the tunnel is about 3,739 ft., and the maximum thickness, near the middle, is 7,003 ft. The elevation at the Swiss entrance is fixed by the high water in the River Rhone, and that at the south end by climatic conditions, and by the vicinity of the old Simplon road which would permit the easy transport of supplies needed for the work. The gradient on the north slope is 0.2%, or as light as is consistent with good drainage of the tunnel; that on the south slope is 0.7%, to overcome the difference in level between the summit and the south entrance. According to the geological experts the rock to be pierced is well adapted to machine drilling, and it is believed that the line of the tunnel will avoid the gypsum strata appearing above Brigue. Admitting that, as at St. Gothard, the augmentation of temperature is above 1° C. for every 44 m. of depth the normal interior heat will touch 40°C., or 104° Fahr. During the driving of the tunnel, however, this heat will be lowered by very liberal ventilation and by sprays of cold water under pressure. For this purpose provision is to be made for admitting 1,765 cu. ft. of air per second, instead of 70.6 cu. ft. as was furnished at the St. Gothard in 1878. The estimated power required for the ventilation, drills, light, etc., is 800 HP. on the north side and 1,700 HP. at the south side.

The method proposed for driving this tunnel is altogether novel and may be described as follows: Instead of a single tunnel with a double line of rails, there will be eventually two separate single tunnels 17 m. apart. At the beginning of the work, on each side of the mountain, two parallel advance galleries or headings will be driven, and these galleries will be tied together, at intervals of 656 ft. by transverse openings, as shown in the accompanying illustrations. One of these galleries, A (Fig. 2), will be enlarged to the completed section, while the gallery B will not be enlarged till the growth of traffic makes a second track necessary. The secondary gallery will have a section of 8 sq. m. and will serve as a channel for ventilation. The entrance doors will be closed and air will be forced in by powerful blowers. All the transverse galleries will be closed by doors, except the two nearest to the working face, and the air forced along the gallery B will penetrate into gallery A by means of the two furthest transverse galleries and will return to the entrance again by gallery A after traversing all the working parts of the tunnel.

The secondary gallery offers other important advantages. All the water tapped in the tunneling operations and that introduced for cooling purposes will be led to a single drain in this gallery so as to leave the working gallery dry; in this gallery B will also be placed the great pipes for conducting water into the tunnel. In the transport of material the cars will enter by this route and will leave the tunnel through gallery A. This circulation of material will do away with the congestion often experienced in the St. Gothard tunnel, and furnishes additional safety, as the stoppage of one heading from any cause will not be likely to block the other also.

The actual driving of the tunnel will be performed in the usual manner. Both galleries will be started together by the use of three or four

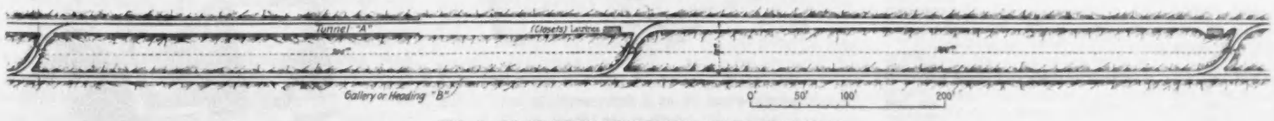


FIG. 3.—PLAN OF PROPOSED PARALLEL HEADINGS.

Brandt hydraulic rotating drills in each face, fed by pipes of 4 ins. diameter. For the first section on the north, in schist, it is expected that a pressure of 70 atmospheres will be required, and 100 atmospheres will be used in the gneiss rock in the southern section. The 12 machines employed, 4 being utilized in cutting the transverse galleries, will consume 18 liters, or 4.7 gallons, of motor-water per second under the pressures given. Based upon experience in other tunnels, Messrs. Brandt & Brandau expect to average an advance of 19 ft. per day of 24 hours through the gneiss rock of the Simplon. Special arrangements have been

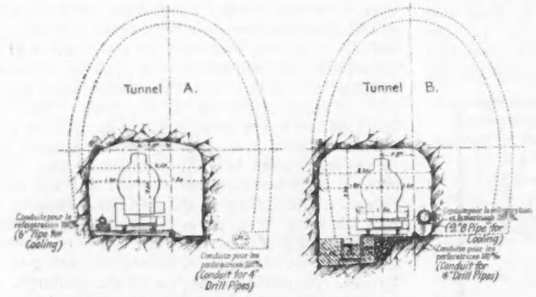


Fig. 2.—Proposed Method of Driving the Simplon Tunnel by Parallel Advance Headings, A and B.

devised for quickly removing the debris after firing a round of holes in the advance face, and these include the use of cranes, etc., operated by hydraulic power.

The system of ventilation proposed, as before outlined, essentially consists of forcing a large quantity of air into gallery B, which air will pass by the two transverse galleries nearest to the advance face into gallery A, and return to the outer air through this last gallery. This air supply provides pure air for the working force and also serves in a measure to cool the rock surfaces. The quantity of air required for the first purpose is relatively small. At the St. Gothard tunnel the volume of fresh air introduced was equivalent to from 53 to 70 cu. ft. per second; at the Arlberg tunnel, the air supply, for a long time, was about 106 cu. ft. per second, but towards the end of the work when the number of workmen had sensibly increased this was raised to 212 cu. ft. In the Simplon tunnel a maximum air supply of 1,765 cu. ft. per second is to be provided. Calculations made show that to lower the temperature of the interior walls of the tunnel 20° C., leaving out of consideration the effect of the ventilating operations, will require the use of 13.5 gallons of water per second at a temperature of 12° C., or 53.6° Fahr. For this purpose from 17.5 to 22.9 gallons per second will be provided; so that even if the interior heat exceeds the estimates of the geologists, the work can be carried on, though the rate of progress may be slower.

As to the cost of construction, the contract made with Brandt, Brandau & Co. contains the following figures:

	Francs.
For the plant, at both ends, including workshops, water pipes, compressors, ventilators, dynamos, locomotives and trains, electric lighting, etc...	7,000,000
For the construction of the first tunnel and parallel heading, with passing point at the center, ballast, laying the rails and ties (the price of these not included), the transverse galleries, etc.	47,500,000
Total	54,500,000

To this the Jura-Simplon Company would have to add, as follows:

	Francs.
Land damages	310,000
North line of access, including stations at Brigue	1,900,000
Rectification of the Rhone	220,000
Rails and ties for first tunnel	640,000
General expenses	1,250,000
Total	4,320,000

The total cost of the single-track tunnel with the parallel gallery would thus be 58,820,000 francs, or $11,764,000. To enlarge the second gallery to a normal section would require $3,244,000 more, including the part paid for by the Jura-Simplon Co., making the total cost of a double-track tunnel, 12.2 miles long, $15,008,000, or about $1,230,000 per mile.

"THE PERFECT AMERICAN 'HURDY-GURDY.'"

The original "hurdy-gurdy" was a crude musical instrument, at one time common in Europe, where it was known as early as the ninth century. The player upon this instrument turned a crank and ground out the music. The same name was given in California in the early gold-mining days to a crude form of impulse water wheel, or "flutter wheel," which had radial flat vanes, just like those of a steamboat paddle-wheel, and was driven by a jet of water ejected at a high velocity from a nozzle. The water upon striking the vanes was necessarily diverted at right angles, causing a loss of a large fraction of the energy of the jet, and as most of the wheels were built by men who had no knowledge of the proper relations of diameter,

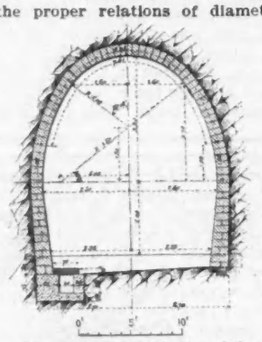


Fig. 4.—Proposed Section of the Simplon Tunnel as Lined.

speed of rim and head of water, their efficiency was very low. In more recent years it was found to be of advantage to make the vanes of a curved form, and about 20 years ago the Pelton wheel

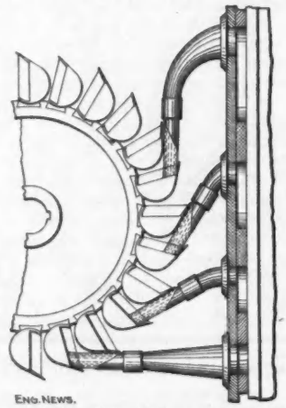


Fig. 1.—The Cazin Wheel, Showing Slide Valve for Cutting Off the Supply to the Nozzles, to Regulate Speed.

was invented, in which a special form was given to the vane or bucket, and a rib was placed in it which divided the incoming jet into two parts, which were thus diverted sidewise, and passing along the curved sides of the bucket, were finally discharged in nearly the opposite direction from that at which the jet entered, and at a velocity

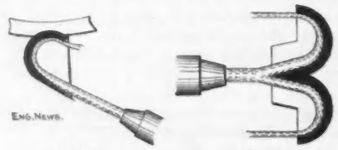


Fig. 2.—Two Sections of the Cazin Vane, (a) in the plane of the wheel, (b) at a right angle to (a).

which was nearly zero referred to the earth. The Pelton wheel obtained efficiencies equal to those obtained by the best turbines, and in consequence it has found a wide field of usefulness, especially where high heads of water were available.

Mr. F. M. F. Cazin, M. Am. Inst. M. E., a mathematician and engineer, of Hoboken, N. J., has invented and patented (March 16, 1897) improvements on the "hurdy-gurdy" type of wheel which are designed more completely to effect the reversal of the direction of the jet to 180° from its line of approach. The wheel has been put on the market by the American Impulse Wheel Co., No. 120 Liberty St., New York. The company has published a pamphlet of 80 pages, entitled "The Perfect American Hurdy-Gurdy," describing the wheel and its merits, and also containing a great deal of information concerning water power, water rights, formulas, illustrative calculations, etc., together with some reprints of mathematical articles by Mr. Cazin. The pamphlet is very different in its literary features from an ordinary trade catalogue; it is, in fact, in many respects more like a technical treatise, but it is written in a peculiar style and presents some ideas which will probably

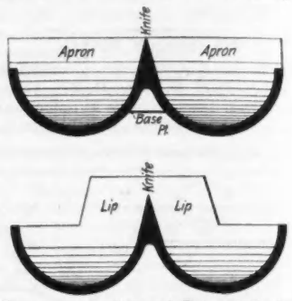


Fig. 3.—Transverse Sections of Pairs of Buckets of the Cazin Wheel.

not be generally accepted by engineers. One of the papers which is printed in the pamphlet states that the formula for the Prony brake, which engineers have been using for 70 years, is inaccurate, and the author gives what he considers to be the correct formula. We cannot give space to a discussion of this subject and the other mathematical propositions of the author, but we advise those of our readers who are interested to send to the American Impulse Wheel Co. for a copy of the pamphlet.

However we may differ from the author concerning his views on the Prony brake formula, we see no reason to doubt that he has designed an exceedingly good impulse water wheel. According to a brief statement on page 29, he has also invented a "steam wheel or rotary engine," and he proposes to provide plants that may be driven "by either water or steam jets, as the season may call for," but no particulars of the construction of the steam wheel are given.

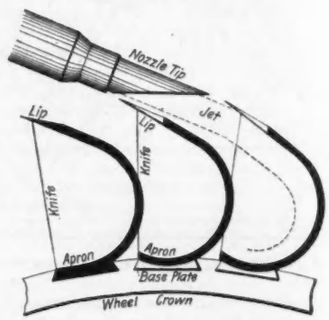


Fig. 4.—Form of Cazin Nozzle and its position with regard to the Vanes.

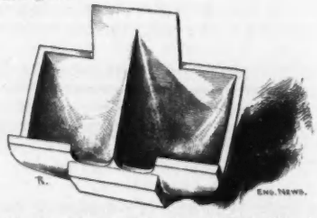


Fig. 5.—Sketch of Bucket of Cazin Wheel.

We give herewith some illustrations showing the Cazin wheel and the form of its buckets, and quote the following remarks concerning it from the pamphlet:

G. R. Bodmer, in his "Hydraulic Motors," says: "The force exerted by the water on the vane (resisting blade or bucket of the wheel) depends solely on the absolute velocity of the former and the form of the path, and depends entirely on the extent to which it is deflected from its original course, and only on the angles of entrance and exit and not upon the intermediate form of the curve, assum-

ing the latter to be a continuous curve and the curvature to be not too abrupt." Notwithstanding the stated fact that the complete and constant inversion of stream was known to be the peremptory condition for highest practical efficiency, no one previous to Cazin attempted to find a form of vane or bucket which would comply with this condition absolutely, viz., completely as to angle and continuously as to various positions occupied relative to the jet.

Pelton inadvertently stopped half way with his improvement. He adopted the diversion of current, abandoned submersion, as Girard did before him, but omitted complete inversion of current and secured only for an instantaneous position of the vane, inversion in part, or non-continuous and abrupt curves. In consequence he failed to achieve the best possible effect.

In the impulse wheel of the American Impulse Wheel Co., protected by the Cazin patents, both vanes or buckets divide the jet into two halves in the central plane of rotation as the best means for inversing the jet-direction. The inversion of the jet is not only complete at 180°, but it is also perfected in all of its successive positions relative to the jets, guiding (as a consequence of its four triangular cavity-sides, bent in semi-circles, with one, the receiving side, beginning in a tangent) the spreading jet-water in all these positions on semi-circular true curves, without irregular counteraction, resulting from abrupt curves and without interruption.

Cazin claims as his invention the form and construction of such vanes or buckets in a power-wheel that will perform all the requirements in compliance with this condition of highest efficiency, namely, the complete and uninterrupted inversion on parallel lines or at 180° in all the different positions that the vane passes through. In the Cazin wheel all vanes project on both sides of the wheel-crown, by means of which projection the exhausted water escapes over the outside edges without possible reaction.

The Cazin wheel is the American hurdy-gurdy wheel improved to a state of theoretical and practical perfection, leaving neither room nor doubt for it ever being equaled or surpassed in efficiency.

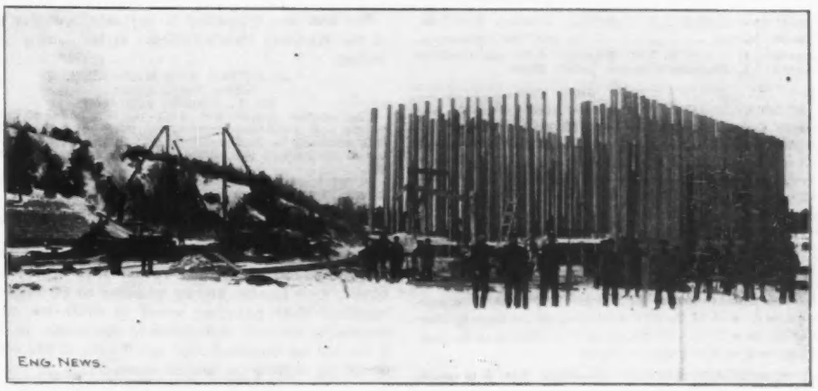
The claim that the Cazin wheel is superior to the Pelton wheel is not likely to remain unchallenged. If the claims made in the pamphlet should lead to a controversy between the makers of rival wheels, we trust it will result in having a series of tests made by experts, in which the efficiency of the several wheels may be accurately determined.

DEEP COFFER-DAM CONSTRUCTION FOR BRIDGE PIERS, PORTLAND & RUMFORD FALLS R. R.

Two coffer-dams built against an unusual head of water and otherwise possessing structural features of interest were recently employed in constructing the masonry piers for a three-span railway bridge across the Androscoggin River in Maine. The bridge was built on the Otis Falls branch of the Portland & Rumford Falls R. R., and consists of three 203-ft. single track spans carried on two masonry abutments and two piers. Neither of the abutments afforded any difficulties out of the ordinary, but the piers were located, respectively, in depths of 28 ft. and 19 ft. of water and quicksand, and in a current of from ten to twelve miles per hour, making the problem of reaching a good foundation bed for the masonry a rather trying one. The method finally adopted for doing the work was designed by the contractors, Mairs & Lewis, of 18 Broadway, New York city, and proved entirely successful.

Briefly described the method adopted was to build on the ice over the pier site a coffer-dam composed of two rectangular shells with the annular space between them filled with puddle and then to cut away the ice and sink the structure. The annular space was first filled to a depth of about 10 ft., and then the sinking began, the structure being held from sinking too far by means of ropes attached to piles driven in a row surrounding the pier site and projecting well above the ice. The boarding of the shells of the coffer-dam and the puddle filling were then continued as rapidly as possible, and the structure gradually sunk as the filling progressed, being always held by the piles and ropes. When the coffer-dam finally reached the quicksand excavation had to be begun, but otherwise, except as noted further along, the sinking was done as in water.

The accompanying engraving shows the coffer-dam for the deepest foundation partly sunk, and gives a general idea of its appearance. At this site the water was 18 ft. deep, and under it were 10 ft. of quicksand. The dimensions of the coffer-dam were 72×39 ft. on the outside and 8 ft. inside was the inner shell. Both shells were built with 8×8 ins. vertical corner posts and 4×8 ins. interior posts spaced 2 ft. apart and rising from an 8×8 ins. bottom sill. The outer shell was planked on the outside with 3-in. plank and thoroughly calked, and the inner shell was similarly planked on the inside, but not calked. The bottom of the 8-ft. annular space was floored at a point 2 ft. above the bottoms of the sills with 3-in. plank, thus leaving the two shells projecting down 2 ft. to form cutting edges for penetrating the sand. Besides the floor the two shells were further braced



COFFER-DAM FOR MAIN PIER OF ANDROSCOGGIN RIVER BRIDGE, SUNK IN 28 FT. OF WATER AND QUICKSAND.

apart across the annular space at every 4 ft. vertically, the braces extending between each post at the bottom, and between alternate posts above this point. Still further rigidity against the side pressure of the water was secured by three rows, vertically, of horizontal 12×12 ins. braces running clear across the structure transversely, and dividing the interior or working chamber into four sections. All timber used was spruce.

As trouble was had from the quicksand being forced up underneath the edges of the coffer-dam into the working chamber the whole structure was banked around with sand; the bank beginning at the top outer edge of the coffer-dam and sloping away on all sides at a slope of about 2 to 1 to the bottom of the river. Inside the inner shell, also, and 2 ft. from it, was driven a row of sheet piling 10 ft. deep enclosing the entire working chamber. The annular space between this sheet piling and the inner shell was filled with puddle. With this construction it was possible to keep the working chamber dry with one 8-in. and two 6-in. centrifugal pumps.

The pier was founded on solid rock which was first cleaned and then covered with about 2 ft. of Portland cement concrete to form a foundation course for the masonry. This masonry was of granite, with a coursed face and rubble backing, coming from the quarries of the Maine & New Hampshire Granite Co., which furnished much of the granite for the tomb of Gen. U. S. Grant, recently dedicated in New York city.

The manner of sinking the foundation for the second pier was exactly the same as already described except in minor details, but here the depth of water was only 14 ft. and of quicksand only 5 ft., or 19 ft. altogether. The total depth of water and quicksand, which, if anything, proved more difficult to resist than water, for the deepest foundation was 28 ft., making about the deepest coffer-dam work which we now call to mind. With the construction adopted, however, the contractors inform us, the only difficulty lay in closely watching and protecting all points from the inflow of the quicksand. The entire work was done in charge of Mr. M. C. Lewis, for the contractors, Mairs & Lewis, of New York city, to whom we are indebted for the information from which this article has been prepared.

AN APPARATUS FOR ACCURATELY MEASURING PRESSURE OF 10,000 LBS. PER SQ. IN. AND OVER.*

By D. S. Jacobus,† M. Am. Soc. M. E.

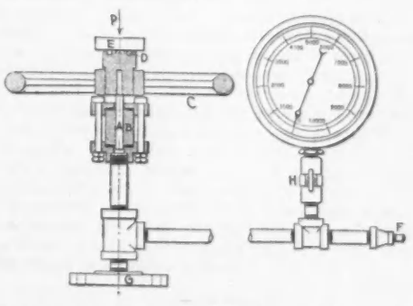
The apparatus is shown in the accompanying cut. The pressure-measuring device consists of a steel plug A, ½-in. in diameter, fitted into a steel bushing B, the hole in which is 0.5005-in. diameter. The top of the plug A is fastened to the centre of the wheel C. E is a steel plate which bears downward on the axis of the wheel C. There is a ball bearing D between the steel plate and the axis of the wheel. G is a circular base for supporting the apparatus.

A pressure is produced by means of a special device, not shown in the sketch. This pressure is transmitted to the measuring device by forcing oil through the ¼-in. pipe F. The oil pressure tends to raise the plug A.

The plug-and-wheel device is placed on a pair of platform scales, or in a testing machine arranged for tests of compressive strength, and the downward force P required to hold the block E in place is accurately measured. To this is added the weight of the wheel C, and of the ball-bearing device and plug, and from this total force the liquid pressure is calculated.

The wheel C is spun around when the weight P is measured, in order to rotate the plug and thus eliminate the effect of friction.

The pipe F which transmits the pressure is about 16 ft. long, and bent in the form of a U, so that any little displacement of the pressure-producing device will not affect the reading of the platform scales.



An Apparatus for Accurately Measuring High Pressures

If a gage is to be tested it is attached at H. The weight P required for a given pressure is calculated, and the scale-beam of the platform scales is adjusted so that it will register this weight. The oil pressure is then increased until the beam of the platform scales is raised, the wheel C being spun to eliminate the effect of friction, and when the scale beam is balanced the gage is read. The reading of the gage for various pressures is thus obtained, and the difference between the readings and the pressures as measured by the plug gives the corrections for the gage.

This apparatus has been employed for calibrating gages to 10,000 lbs. pressure, and for measuring pressures as high as 15,000 lbs. per sq. in. and has given entire satisfaction.

*A paper presented at the Hartford meeting of the American Society of Mechanical Engineers.

†Professor of Experimental Mechanics and Shop Work, Stevens Institute, Hoboken, N. J.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The Supreme Court decision handed down on May 24, denying the power of the Interstate Commerce Commission to fix railway rates, will doubtless still further hamper that body in the enforcement of the Interstate Commerce law. The Supreme Court appears to rule that the power of the Commission is strictly limited to passing upon rates when put in force by the railway companies. The Commission can decide that a certain rate is unreasonable or excessive or discriminating, and the railway company must then cease to charge such a rate, but the Commission has no power to say what rates shall be charged, or even what shall be a maximum or a minimum rate. Of course, under these circumstances a decision by the Commission amounts to nothing whatever, if the railway company chooses to disregard its spirit. If a given rate is declared unreasonable, the railway company can at once put in force another rate a trifle larger or smaller than the rate which has been the subject of inquiry, and the Commission must pass upon this rate. Under this new ruling, it appears to be clear that if Congress wishes to give the Commission any power whatever to regulate rates, it will have to pass further legislation. It is a mere farce to investigate the reasonableness of a rate and formally annul it, unless the body that does this has authority also to indicate at least the limits between which rates would be lawful.

The two most notable things about the Philadelphia water supply are its pollution and the wastefulness with which it is used. We have so frequently commented on these facts that further remarks are unnecessary. In another column we publish an outline of a plan presented by Mr. Jno. C. Trautwine, Assoc. Am. Soc. C. E., Chief of the Bureau of Water, for the improvement of the supply of a section of the city known as West Philadelphia, which suffers most from the condition of the water, owing to a lack of reservoir capacity, and thus of sedimentation. Mr. Trautwine recommends that a slow sand filtration plant be at once provided for purifying the water of this section of the city, and accompanies this advice with the obviously necessary recommendation that the enormous waste now prevailing be curtailed by the use of meters. It is sufficiently appalling to think of the expense of pumping the vast quantities of water wasted in Philadelphia, but when to the expense of pumping is added the capital charges and operating expenses of a filtration plant, any sane man must see that the waste must be cut off or else those who waste must be made to pay the bills. Slow sand filtration is in use in many places outside of Philadelphia, and has been found eminently successful in the purfication of water. Meters are in use in many places outside of Philadelphia and have been found to reduce waste and not to interfere with the legitimate use of water. Foul water and reckless wasting of the supply have been the rule in Philadelphia for many years, and it is high time the city began to profit by other cities' experience and take steps to bring about a change.

We find the following in the catalogue for 1897 of the Working Men's College, at Melbourne, Australia:

GRAINING AND MARBLING.
Three Years' Course.
Mr. F. Ellemor, Instructor.

The course commences with the methods of mixing paints and preparing grounds for graining and marbling. Oak graining is thoroughly taught in the first place, followed by pollard oak, maple, walnut, cedar, satin wood, etc.

In marbling the following are taught: Black and gold, sienna, dove, jaspers, jet.

A fine collection of woods and marbles has been procured from England at considerable cost, as specimens for copying from.

The Working Men's College is a sort of trade and industrial school and engineering school combined. One hardly knows whether to be more astonished that painting wood in imitation of its natural grain still flourishes in Australia, or that it should be expected that any youth in his senses would be willing to devote three years of his life to acquiring skill in a trade which depends for its existence on a passing fashion.

It appears to us that this is an extreme illustration of a too common tendency in engineering schools, against which, however, we are glad to say, the bulk of the professors in these schools are fighting. It ought to be plain enough that if a youth is to spend three to five of the most important years of his life, after his period of earning power has begun, he should spend these years in acquiring something that will benefit him as long as he lives. There are courses of study in engineering schools which will benefit all his life the student who pursues them, in whatever branch of engineering he may follow; and they will benefit him greatly, even if he does not follow engineering at all; but engages in commercial pursuits or follows some other profession. On the other hand, there are other courses of study in engineering schools, established often, it is fair to say, in response to an urgent demand on the part of students, parents, and "powers that be," in which the student spends a large part of his time in acquiring knowledge and skill of which a large part is likely to be as useless to him in after life as the ability to do a job of "graining" will be to a Working Men's College graduate when the Australians advance a little further in aesthetic taste.

Those of our readers who are interested in the discussion of the question, "What is the elastic limit?" should read what is said on the subject in the review, printed elsewhere in this week's issue, of Prof. Johnson's new book on "The Materials of Construction." The new definition of Prof Johnson, which is the result of many years' study of the subject in the testing laboratory, is as follows: "The elastic limit is that point on the stress-diagram where the rate of deformation is 50 per cent. greater than it is at the origin." The wording of the definition presupposes that a stress-diagram is either plotted from the records of load and deformation obtained in the test or made by an autographic instrument attached to the testing machine. The definition may evidently be so worded as not to refer to such a stress-diagram, and so as to be capable of application directly to the record of successive loads and deformations, as follows: "The elastic limit is that point at which the ratio of increase of deformation to increase of load is 50 per cent. greater than the constant ratio which exists between zero load and the load which first causes an increase in the ratio." Or: "The elastic limit is that point at which the increment of deformation for a given increment of load is 50 per cent. greater than it is below that point at which the deformation begins to increase in greater proportion than the load." Or, again: "The elastic limit is that point at which the instantaneous modulus of elasticity is two-thirds of the maximum modulus"; the words "instantaneous modulus" being understood to be the quotient obtained by dividing the increment of load per unit of section by the increment elongation (or compression) per unit of length, as distinguished from what is usually called the modulus of elasticity, which is the total load per unit of section divided by the total elongation per unit of length produced by that load.

Prof. Johnson bespeaks for his discussion of the elastic limit a careful consideration, and after a study of the many stress-diagrams scattered through the book, before his views are condemned. For ourselves, we think his position is well taken, and that he has rendered a valuable service to the engineering world in formulating the new definition.

In our issue of May 13, we quoted from our contemporary, "Compressed Air," an account of a hydraulic bursting test of a Mannesmann bottle or reservoir for storing compressed air, which was so worded that it was liable to be misinterpreted by the non-technical reader, and to lead him to suppose that the bursting by hydraulic pressure was similar in its action to the bursting by an excess of air pressure. As a matter of fact, the article was so misinterpreted by the daily press which quoted and commented upon it. We said at the time that we could hardly believe our contemporary intended to mislead its readers, and we have since then received satisfactory evidence that the article was published with no such intention; but was given merely as a record of a test to determine the factor of safety of the compressed air bottle. Under these circumstances we are glad to withdraw the criticism which we made of our contemporary. It would have been well had it carefully explained, as did "The American Machinist," in describing the same test, that bursting by hydraulic pressure was not identical with bursting by compressed air pressure; but its omission to do this came doubtless from the fact that its editors were so familiar with this matter that it did not occur to them that their account would be misunderstood.

PRECAUTIONS TO BE OBSERVED IN RECLAIMING SUBMERGED LAND BY FILLING.

The reclamation of submerged land or tidal flats has become an important class of engineering work, not only in the older seaports of the world, but in some of the newer cities and harbors of the Pacific coast. In the cities of Seattle and Tacoma, Wash., large acres of mud flats and shoals extend between the solid land of the city and the deep water of the harbor. Instead of dredging out deep water channels through the mud flats to give access to wharves and piers built approximately along the line of solid ground, the opposite policy has been adopted, and the flats are being filled in to bring them above the surface of the water and thus convert them into new solid ground or "made land," which may be available for commercial purposes. By this method an extension of the city's area is formed in an advantageous direction, and the additional area can be so laid out as to afford the best outline of the water front, the best facilities for shipping and the handling of freight, and the best arrangement of railway freight terminals.

In our issue of Dec. 31, 1896, we referred to the work being carried out at the two cities named above, and in another column we give some further particulars of the work at Seattle. In this latter case, where work is being prosecuted more actively than at Tacoma, plans for the harbor have been prepared by engineers and definitely adopted, and plans have also been adopted for the construction of terminals and shipping facilities on the most modern principles. The work there also receives an impetus from the carrying out of canal excavation to connect the harbor (Puget Sound) with Lake Washington, the excavated material from the canal being utilized as filling material upon the flats.

The plan for thus reclaiming submerged land is, of course, a simple one, but it may be well to point out at this time the fact (which is obvious to any

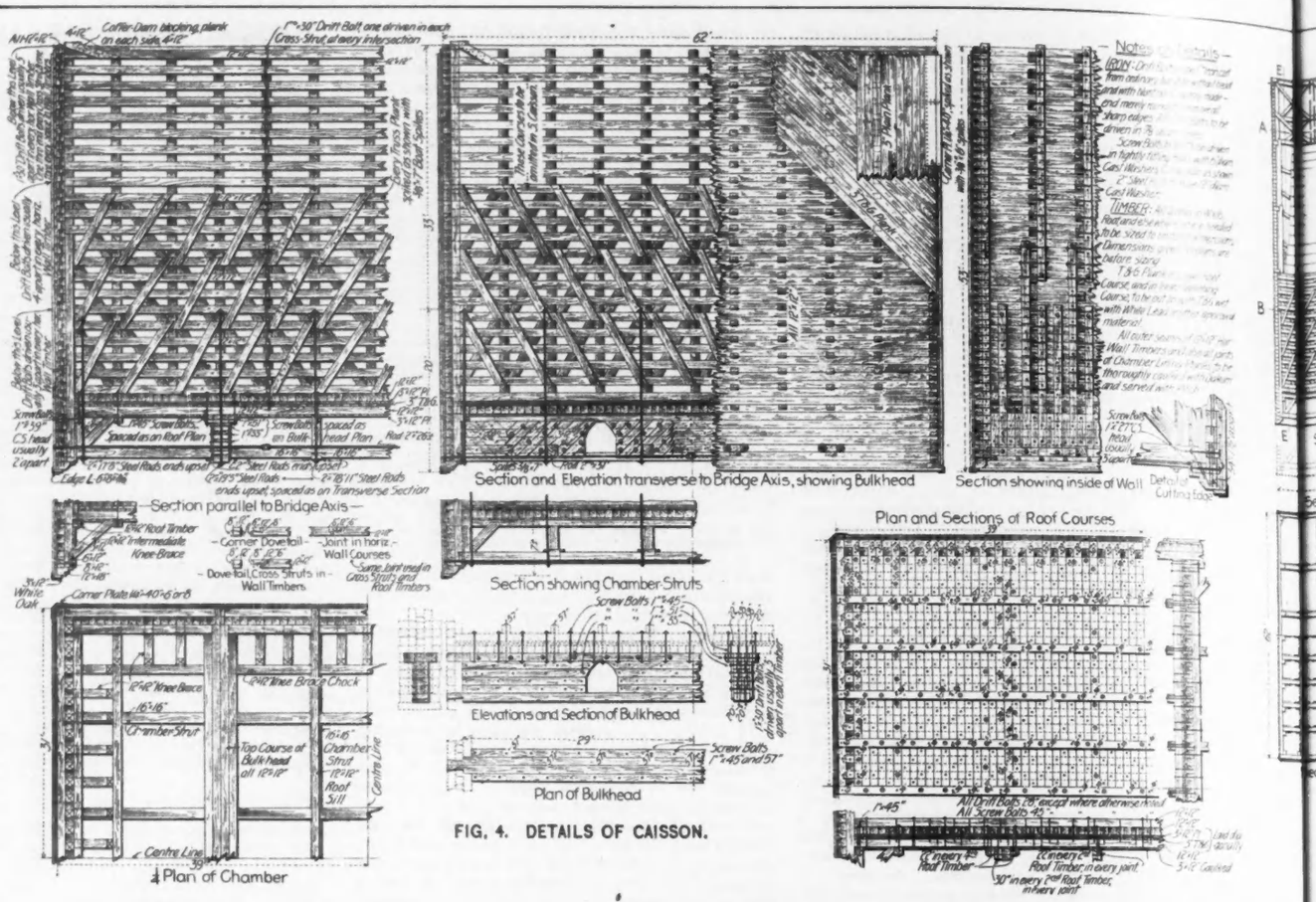

Section and Elevation transverse to Bridge Axis, showing Bulkhead
Section showing inside of Wall
Section parallel to Bridge Axis
Section showing Chamber Struts
Plan and Sections of Roof Courses
Elevations and Section of Bulkhead
Plan of Bulkhead
Plan of Chamber
Notes on Details

FIG. 4. DETAILS OF CAISSON.

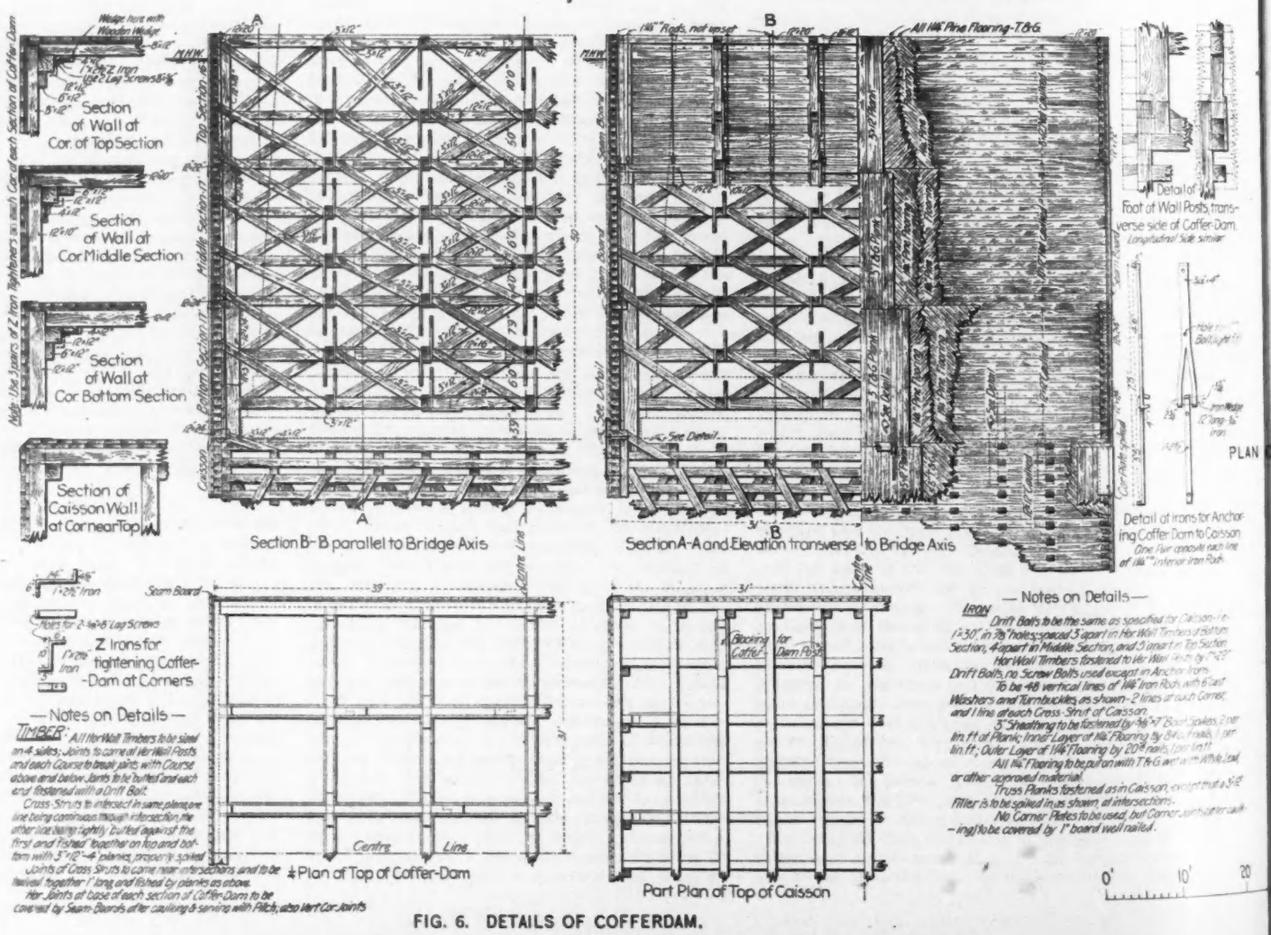

Section of Wall at Cor. of Top Section
Section of Wall at Cor. Middle Section
Section of Wall at Cor. Bottom Section
Section of Caisson Wall at Cor. near Top
Section B-B parallel to Bridge Axis
Section A-A and Elevation transverse to Bridge Axis
Detail of Foot of Wall Posts, transverse side of Coffer-Dam
Detail at Irons for Anchoring Coffer-Dam to Caisson
Z Irons for tightening Coffer-Dam at Corners
Plan of Top of Coffer-Dam
Part Plan of Top of Caisson
— Notes on Details —

FIG. 6. DETAILS OF COFFERDAM.

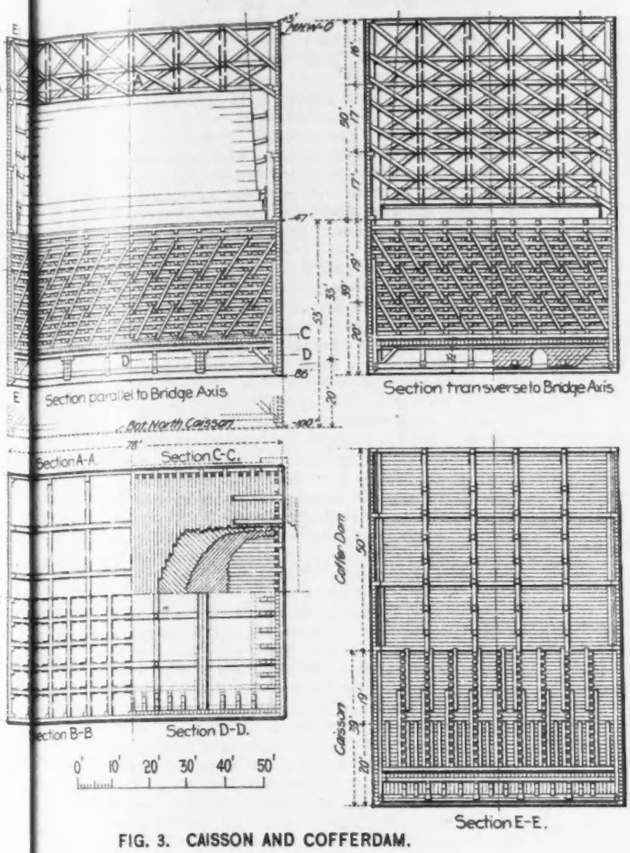


FIG. 3. CAISSON AND COFFERDAM.

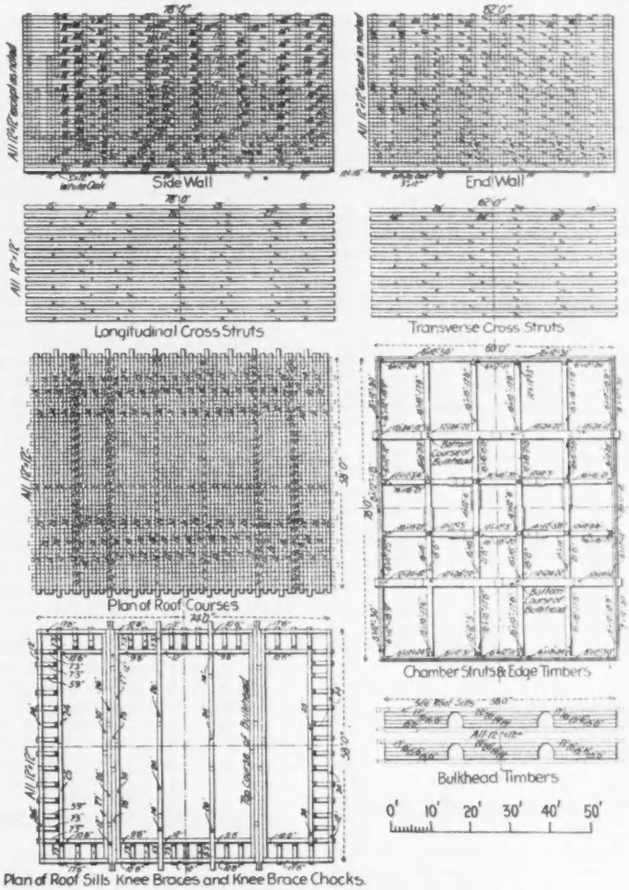
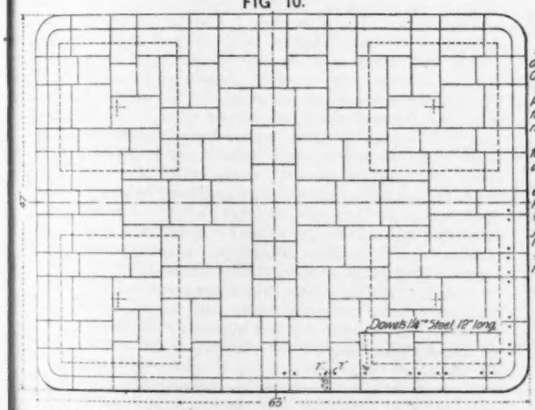

Side Wall
End Wall
Longitudinal Cross Struts
Transverse Cross Struts
Plan of Roof Courses
Chamber Struts & Edge Timbers
Bulkhead Timbers
Plan of Roof Sills Knee Braces and Knee Brace Chocks.
0' 10' 20' 30' 40' 50'

FIG. 5. MATERIAL SHEET FOR CAISSONS.

FIG 10.


All exposed edges of Upper Coping Course to be "6 cut." Areas under the Pedestals (shown by the dotted squares) need not be "6 cut." All Edge Stones cut to lay with 4/4" beds and 4/4" vertical joints. All Interior Stones, except those under the Pedestals, to lay with 1/2" beds, and 4/4" vertical joints; those under Pedestals, to lay with 1/2" beds and 1/2" vertical joints.
Pedestals to be "6 cut" on all edges, and on top beds, except within dotted squares. Areas within dotted squares to be "rough pointed." Stones in Pedestals to be laid on 1/2" beds with 1/4" vertical joints.
Dowels 1/4" Steel 12" long
65'

PLAN OF UPPER COPING COURSE, SHOWING DOWELS FOR FACE STONES.

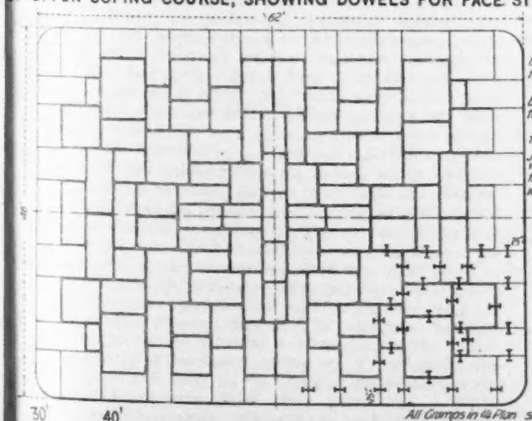

62'
Exposed edges of the Lower Coping Course to be "6 cut."
Both Face Stones and Backing Stones to be cut to lay on 1/2 mortar bed
Face Stones to be cut to lay with 4/4" vertical joints, Backing Stones with vertical joints not more than 2" at any point and with stones not in contact.
15" 1" Square
1" Square
Detail of Cramp
All Cramps in 4th Plan shown alone.
30' 40'

FIG. 11.

PLAN OF LOWER COPING COURSE, SHOWING STEEL CRAMPS.

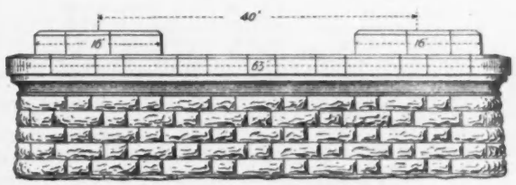


FIG. 7. PART SIDE ELEVATION OF PIER.

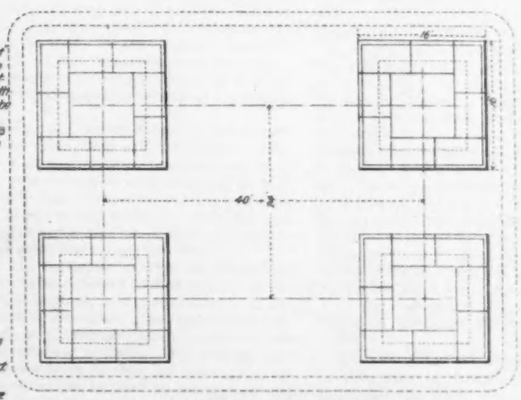


FIG. 9. PLAN OF PEDESTAL BLOCKS.

FOUNDATIONS OF THE BROOKLYN TOWER OF THE NEW EAST RIVER BRIDGE.

L. L. Buck, M. Am. Soc. C. E.,
Chief Engineer.

CHAS. HART & SONS, LITH., 111 NASSAU ST., N. Y.

engineer) that this method involves questions of foundations, and that careful investigation should be made as to the character and depth of the material of the flats, and the character and surface slope of the underlying strata, while the character of the filling material must also be taken into consideration. If such work is undertaken without due investigation in these respects, the filling may simply cause the mud flats to spread out, or to rise up in unexpected (and perhaps undesirable) places, or it may form apparently solid ground which later on, under the effects of vibration from traffic or loading by large grain elevators, etc., may settle down into the mud or slide with the underlying bed of mud upon an inclined surface of the hard stratum below the mud. Precautionary measures are as necessary in this kind of work as in filling in banks to replace railway trestles with earthwork, which latter kind of work was discussed at some length in our issue of Nov. 28, 1895. A warning in this direction is afforded by the landslide at Tacoma in 1894, where a large section of filled land broke away from the original ground and not only slid out but sunk vertically. It is true that investigation showed this to have been the result of a seismic disturbance, and not to an overloading of the submerged land, but the effect was exactly that which might be expected to follow the careless carrying out of such reclamation work as is here referred to.

In work of this kind, it is important that plans of the harbor lines, and the positions of docks, buildings, etc., should be prepared and definitely adopted before the filling is commenced. If the future location of any especially large or heavy structures is known at the time the filling is done, special care should be taken to ascertain the depth and slope of the hard stratum below the mud at these sites, and to ensure that the filling material there used is of good and suitable quality.

Another point to be considered is the construction of the bulkhead walls and wharves. These works will frequently be of timber, at any rate during the first construction, and these should be designed to resist the pressure of the soft filling material so as to prevent bulging or overthowing, which might, perhaps, lead to damage to shipping, or buildings. If the teredo or other destructive insect is present in large quantities and renders frequent and expensive repairs necessary, the early replacement of these temporary structures by permanent masonry structures may be a question for consideration in an early stage of the works. With harbor improvements of this kind in foreign countries the face works, as they may be termed, are usually of permanent character from the first, being often built out on the deep water line, and the filling in being then done behind them. In this country, however, the face works are usually temporary. This is, of course, due largely to the expense of permanent works and the comparatively small immediate revenue from traffic. There are, however, some advantages in delaying the construction of permanent masonry structures until the filled-in material and the soft material on which it lies are thoroughly settled and consolidated by the lapse of time, and are less liable to movement. The construction of permanent works in the first place has, however, been practised in some cases in this country. In 1874 work was commenced at Boston for reclaiming the South Boston flats, and this work consisted in the construction of sea-walls or bulkhead walls of masonry, forming the west and south sides of Fort Point Channel, with a dock 850 × 165 ft. The walls were backed with oyster shells and gravel, having a slope of 45° from the top of the wall. The area to be filled in was about 1,000,000 sq. ft., and the material used was stiff clay dredged from the harbor which was distributed by small cars on tramways and trestles. This material became, by handling, of a semi-fluid consistency, weighing 125 lbs. per cu. ft., so that great care was necessary in depositing it near the walls. It was usually deposited in a layer 4 or 5 ft. in thickness; this layer being left for several weeks to become consolidated while work was going on at other places. This work is fully described in a paper by Mr. Edward S. Philbrick, in the Transactions of the American Society of Civil Engineers, February, 1878. In the filling of the Potomac flats, at Washington, D. C. (Eng. News, Jan. 4, 1894), the construction of boundary embankments for the channels was carried on simultaneously with the deposition of the dredged material upon the flats.

The filling may be done in various ways, according to the locality and the character of the available material. At Seattle it is being done partly by pumping mud excavated by suction dredges and partly by excavating dry ground by water jets and washing the debris down to the flats. These flats are under 12 to 18 ft. of water at high tide, and the grade of the top of the embankment to be built upon them will be 2 ft. above the highest known tide. It will be evident that the safe and economical filling in of banks in 12 to 18 ft. of water calls for care and supervision in the planning and execution of the work.

One important point which should by no means be overlooked at this time, when the importance of sanitation is becoming more generally recognized, is the possible effect of such "made land" upon the health of its future occupants. If the surface of the old mud is covered with a foul layer of garbage and refuse which is exposed at low tide, there may be an injurious effect upon the health of the people living near the water front. This may be reduced by filling in the flats, but, on the other hand, if buildings are erected on such "made land" the dampness or the exhalations from the material may have an injurious effect upon the health of the occupants. This, however, may be in part avoided by making the top of the embankment of clean gravel, as at the South Boston flats, above referred to, where the clay filling had a top layer of clean gravel 3 ft. thick. If the filling should be mainly sand there would probably be but little trouble from dampness, as the sand would soon dry out.

It will be understood that all the above are presented merely as suggestions of the precautions which need to be exercised in carrying out the class of works under discussion and no reference whatever is intended to the methods in use at any particular place.

LETTERS TO THE EDITOR.

The Theory of the Ideal Column.

Sir: The formula referred to in the last paragraph of my reply to the discussion of my paper on columns (Eng. News, May 20), appeared in the proof sent to me of Prof. Du Bois' discussion, but did not appear in the discussion as published in your last issue. For the benefit of those who may have followed the published discussion, will you kindly explain to your readers that the reference to the formula should also have been omitted? Yours respectfully,

Henry S. Prichard.

Trenton, N. J., May 25, 1897.

The New Holyoke Water Power Dam.

Sir: Since the publication of my article on the Holyoke dam, which appeared in your paper of May 13, my attention has been called to the fact that I did not make very distinct reference to the repairs which were made between the years 1879 and 1885, and to the work which was done at that time in preparation for the probable future construction of a stone dam. This work is described in detail in the paper by Mr. Clemens Herschel, published in Vol. XV. of the "Transactions of the American Society of Civil Engineers," but for the benefit of those who have not access to this paper a few further statements may be of interest.

As I stated in my article, the first break in the plank covering appeared in 1879. This and subsequent breaks were repaired by means of square cribs sunk so as to enclose the break. The cribs were without top or bottom, and on the under side were cut to a bevel to fit the slope of the dam. No pumping was necessary when working inside of them, as the water drained off through the hole in the dam as fast as it leaked into the crib.

When the dam was replanked in 1885, a similar although, of course, a more elaborate method was employed. The work was done in sections, only a small portion of the dam being laid bare at one time. The entire dam was replanked, a row of sheet piling put into it, and filled with gravel, during the summer of 1885. The methods employed for stopping the leaks in 1893 and 1894 could not have been possible previous to 1885 on account of the rotten condition of the planking. In fact, if the dam had not been thoroughly repaired and replanked, as described, in 1885, it would undoubtedly have been carried away before the following summer.

Mr. Herschel, who was engineer of the Water Power Co. from 1879 to 1889, made during this time a design for a stone dam which is published in connection with the paper mentioned above. The section chosen by him, which differs immaterially from the design finally adopted by the Water Power Co., was selected after several experiments with models built on a scale of one-twelfth full size. The models were set up in an old canal lock in such a position that a miniature freshet could be poured over them.

I wish, also, to state that the cement used in the new dam is being furnished through Messrs. Jas. A. Davis & Co., 92 State St., Boston, who are the New England agents for the Alpha Portland cement.

I am informed that the present length of the stone pile is in the neighborhood of 1,300 ft.

Yours truly, Sanford A. Thompson.

Newton Highlands, Mass., May 24, 1897.

Sheet Piling and Stone vs. Timber in Dry-Dock Construction.

Sir: Your editorial note in your issue of May 20 on the leakage of the dry-dock at the Brooklyn Navy Yard, while commenting most pertinently on the wisdom of building such a structure in such ground, gives a wrong impression concerning the functions of various features of the work, and also in the actual protection against leakage, which, in view of the large amount of unjust criticism already borne by the civil engineers of the Navy, should be corrected.

It should not be understood that the clay puddle in the sides of the dock is in any sense a protection against the entrance of large bodies of water. It is simply to prevent the wash of water in and out between the altars as the dock is filled or emptied, and also to prevent the seepage of ground (rain) water, and for these purposes it has proved itself quite as efficient as is needful. The dock is not dependent on the integrity of a single line of sheet piling, but, where most exposed, by four lines, and in all places by two lines, most of which the writer understands to be of 12-in. grooved and splined material.

With respect to the timbers, cribs, stones, etc., used in filling up the area (formerly under water) covered by this structure, the writer understands that it was the intention to remove all such obstructions as would interfere with the lines of sheet piling before it was driven. There should not be overmuch difficulty in obtaining water-tight lines of sheet piling in such soil, and this has apparently been practically demonstrated in the construction of Dock No. 2, not more than 300 ft. distant from the dock under consideration, and which has been in use some seven years; although its successful operation for this period is no absolute proof that somewhere underneath the surface there are not serious defects slowly developing trouble for a future day.

The writer believes that the main fault is not so much in the plan of using sheet piling as in the method of driving it. To attempt, as was done here, in ground composed of, first, filling (ashes, etc.), then stiff mud or clay underlaid by dense, hard quicksand, to put down piles without first breaking up the sand with a water jet, means infinite pains and patience or a large percentage of shattered sticks. The average pile driver foreman counts his success in the number of sticks driven daily, not in patience or pains put out of sight below the surface. The writer believes from his experience in similar ground adjacent to the Navy Yard, and from his observation of the Navy Yard work, that the sheet piling of the dry-dock must be more or less defective as a water-tight bulkhead.

Whatever may be the defects in this particular case, you strike the vitals of the matter in saying that the initial cost of a dock is hardly of the importance that its service is in times of great need. A timber dock is very susceptible to decay and damage. (The indications are that the present failure is due to external damage.) A bulkhead of sheet piling cannot be inspected below the surface. Its efficiency must at the best be problematical. After years of successful operation in times of peace, defects may develop at the most inopportune moment in times of war, causing fearful disaster.

A masonry structure, however, is not susceptible to decay and is far more obdurate to damage. Every portion of it is open to inspection, and, when completed, its efficiency is absolutely known. It can be depended on. A timber dock can always subserve commercial needs, but as an essential accessory in the maintenance of a fighting fleet, its large measure of unreliability (particularly in such ground as is found in the Brooklyn Navy Yard) must bring on Congress (not the Navy Department) the most serious criticism for building such a structure. The writer understands that the engineers of the Bureau of Yards and Docks have a strong preference for masonry docks, advocate them in all cases, and only build them of timber because Congress will not appropriate sufficient means for more costly structures. Very respectfully,

W. E. Belknap, Engineer Wallabout Improvement.

Room 49, Municipal Building, Brooklyn, N. Y., May 22, 1897.

(In our editorial comment we omitted to refer to the lines of sheet piling enclosing the concrete floor, as the chief source of leakage at that time seemed to be through the sides of the dock, or between the altars. But since our last issue, later investigation has seemingly located the source of trouble somewhere in front of the entrance to the dock; and it is now supposed that dredging operations at this entrance either damaged or partially lifted some of the sheet piling at that point. The thickness of the sheet piling actually used at these Brooklyn docks was 5 and 8 ins., as noted; but 12-in. piling has been suggested for the repairs. In regard to stone vs. timber construction for dry-docks, we understand the position of the engineers

of the Bureau of Yards and Docks to be about as follows: In the northern ports stone is very liable to be displaced by the action of frost, and much trouble has arisen from that cause. As timber will last longer in the colder climate, it is not only cheaper, but is better than stone, when the site is otherwise suitable; especially if the timber is supplemented by concrete, as we have already noted. In Southern waters, on the other hand, the frost action is absent, and timber will decay more rapidly and is more liable to serious damage from the teredo, and there stone is more suitable than timber, other things being equal. The most approved practice of the Bureau now calls for masonry backed by concrete in the entrance of timber docks, as exemplified at the Puget Sound drydock. We certainly did not intend any "unjust criticism" on the civil engineers of the navy; for we fully recognize the difficulties of their position, serving as they do under a Chief of Bureau, who is not an engineer and who cannot appreciate the full force of recommendations coming from the technical staff. What we did criticise was the short-sighted economy of the head of a Department, or a Chief of Bureau, who would order, simply because it was less expensive, a class of work not altogether suited to the locality. In all engineering work, conditions of site and the future efficiency and permanency of the structure should control both the type and the initial cost of construction. And this rule should especially apply to so important a work as the government drydock.—Ed.)

Concrete and Tile in the Pittsburg Fire.

Sir: In the report in the daily press of Saturday last, of the meeting of the National Board of Fire Underwriters, I find the following paragraph:

F. C. Moore, president of the Continental of this city, in a report on the construction of buildings, praised the efficacy of the present building laws in this city, and suggested that a model building law should be formulated by the Board.

You will note that this Mr. Moore talking, is the Mr. Moore who talked before the Mayor recently at the hearing concerning the legislative bill proposing to abolish the Board of Examiners.

I would like to ask Mr. Moore a few questions, referring especially to the efficacy of the building laws of this city, which he praises so highly. Mr. Moore is one of the members of the Board of Examiners, which Board stands in the way (as your editorial of last issue very emphatically says) of better building operations in New York. I would like to ask him in what position the owners of the Methodist Publishing Co., of Pittsburg, Pa., would be to-day if his model Board of Examiners had been in that city a few years ago, when their building was put up. They would most certainly have prevented the use of a concrete floor, and compelled the owners of that building to use a hollow tile floor.

The owners of the big dry-goods store across Penn Ave. from the building in which the fire originated, might be valuable people for him to interview. It might also be pertinent to inquire whether his company carried any policies on the dry-goods building, and also whether they carried any on the Methodist building, and if they did, what his Board of Directors think of the desirability of the two as insurance risks.

Yours truly Merrill Watson.

256 Broadway, New York, May 17, 1897.

(We submitted a proof of the above letter to Mr. Moore and append his reply as follows.)

Sir: I am in receipt of your favor of May 18, enclosing proof of criticism of my remarks at the recent meeting of the National Board of Fire Underwriters, and of my position as a member of the Board of Examiners of the Building Department, with regard to the various patent fireproof floors submitted as substitutes for the floors required by law. I appreciate the opportunity you have given me of having my reply to Mr. Watson's article appear in the same issue of your paper with his criticism. It seems to me that it is in the interest of the public, and only just to the individual criticised, that a journal which gives publicity to criticism should be fair enough to extend to the one criticised the same audience and opportunity afforded to the critic.

I am glad to have the opportunity of stating my position in the Board of Examiners with regard to the various forms of fireproof floors now in the market.

Section 484 of Chapter 275 of the Laws of 1892 reads as follows:

All brick or stone arches placed between iron or steel floor beams shall be at least four inches thick and have a rise of at least 1¼ inches to each foot of span between the beams; arches of over five feet span shall be properly increased in thickness, as required by the Superintendent of Buildings.

Or the space between the beams may be filled in with sectional hollow brick of hard burned clay, porous terra cotta, or some equally good fireproof material, having a depth of not less than 1¼ inches to each foot of span, a variable distance being allowed of not over six inches in the span between the beams.

Section 504, in connection with the Board of Examiners, provides as follows:

In cases in which it is claimed by an owner, in person or by his representative, that the provisions of this title do not directly apply, or that an equally good and more desirable form of construction can be employed in any specific case than that required by this title, then such person shall have the right to present a petition to the Board of Examiners, through the Superintendent of Buildings, and may appear before said board and be heard; and said Board shall consider such petition in its regular order of business, and as soon as practicable render a decision thereon.

Under these provisions, applications have been made to the Board of Examiners to approve as equally good with the porous terra cotta or burnt clay sectional arches, or brick segmental arches, various patent floors—the Metropolitan, Roebling, Fawcett, Rapp, Columbian, Expanded Metal, Guastavino, etc., etc. Most of these floors are fully illustrated in Mr. Kidder's work, "Building Construction and Superintendence." That they have great merit, when put in properly, would not be denied; I do not believe any of them, however, equal to a brick arch, and whether or not they are equal to a sectional tile arch, with skewbacks provided with lips for protecting the soffits of iron beams, is a question as to which experts differ.

It is urged that much of the porous terra cotta or burned clay tiling in the market is defective, and that the floors mentioned are superior to such defective material. The same may be said of defective brick; but the law contemplates and specifies that only properly burned brick shall be used, and it is the duty of the Building Department to see that "pale" brick, "swells," etc., are not employed.

My education in fires leads me to believe that merchandise should not be stored, even in fireproof buildings, at a greater height from the street level than 95 ft., that being the maximum height at which a fire department can handle a fire, although it is claimed that the New York Department can control a fire at 125 ft. from the grade, under favorable conditions. When, therefore, a building occupied for mercantile purposes gets to the height of 95 ft., or for office purposes say 125 ft., it seems to me the law should not be relaxed in any particular. Inasmuch, therefore, as floors whose stability depends on their being carefully prepared, especially those made of concrete, cement, etc., may not be put in with the same care with which the samples are prepared for the public fire tests, the Board of Examiners have been unwilling to vote for these floors as equally good with the construction required by law. Cement, of course, should be of the best quality, sand should be sharp, concrete or other mixtures requiring water should not be made in freezing weather, etc., etc. Indeed, so much depends on faithful work and so impossible is it for the Building Department to keep track of the floors throughout the numerous large buildings in course of construction, that I have been unwilling to depart from the law in high structures.

It is urged, as before stated, that the tile arches are often defective; but my answer is, the law has specified them and leaves it with the Building Department to inspect them and reject defective material.

The various fire tests that have been made of these floors are offered as reasons why they should be regarded as equally good, but this claim overlooks the fact that in those particularly which depend for a bond on iron or wire it has not yet been demonstrated (for only experience can demonstrate the fact) that the iron will not rust out in course of time.

It should be borne in mind, also, that as these composite floors are lighter than brick arches or segmental arches of tile, the factors of safety in the iron beams and story posts are less, resulting in the use of less metal—a serious matter in buildings of great height, which need weight to insure stability against wind pressure, etc.

We have endeavored to be liberal with these floors and have consented to their use in buildings 20 ft. higher than the law permits for wooden joisted buildings, holding that a building 95 ft. in height, for example, with iron beams and these floors, would be at least equal to, if not better than a building 75 ft. high (the height permitted by law), with wooden floor joints. To this extent we have consented to the use of these substitutes for tile and brick arches, requiring, however, that the span of iron beams shall in no case exceed 5 ft.

Your critic will, therefore, understand my position to be this: believing that in all buildings exceeding 95 ft. in height the most thoroughly fireproof and durable material from rust and other standpoints should be employed, I am unwilling to vote for substitutes of the material required by law until experience has demonstrated their durability, and until we can be sure of supervision which will insure their being put in by contractors in all cases with the same care with which the samples are prepared for public tests.

The Continental Insurance Company's building, in which I am writing this letter, was constructed by us in line with this idea; indeed, believing that the requirements of the building law as to thickness of walls were not stringent enough, we made our enclosing walls 4 ins. thicker on every floor than the law requires.

Please understand that, as an underwriter, I have no business interest in the matter. Fireproof construction is no more profitable to us than wooden construction. Our rates and the amounts which we write are based upon existing conditions. We are quite as willing to secure a hundred dollar premium on a frame planing mill above the Harlem at the rate of 5% as to secure the same premium by a line of $100,000 on the fire-proof office building of the Mutual Life Ins. Co. at the rate of one-tenth of 1%. By the burning of the former we would lose $2,000, and the probability is that a fire in the latter structure would not cost us, on a $100,000 policy, with co-insurance provisions, more than the same amount. In serving on the Board of Examiners it has been my endeavor to be liberal in construing the law and conscientious in the discharge of my duty to the city at large, and I trust I have made it clear that from the standpoint of my business interests, as an officer of an insurance company, it makes no difference to me whatever whether buildings are properly built or not; all I need is to know the facts and gage my rates and lines accordingly. In my opinion, the day is not far distant when 95 ft. will be regarded as the maximum height for buildings of mercantile or manufacturing occupancy, and 200 ft. the maximum height for office occupancy, under the most favorable conditions of width of streets and protection of fire departments.

Mr. Watson asks in what position the owners of the Methodist Publishing Company, of Pittsburg, Pa., would be to-day if they had been prevented from using a concrete floor, which they did use, and draws comparison with the so-called fireproof Horne building, which was so severely damaged. I have not had opportunity to carefully study the reports of this fire, but would state that the Methodist Publishing building, to which he refers, was not exposed to the full force of the burning of the large grocery store which was directly opposite the Horne building and caused its destruction; but Mr. S. H. Lockett, an expert who reported as to this fire, and whose report can be read by Mr. Watson in the issue of the "Journal of Commerce" of 18th inst., says the following:

It may be interesting to know the effect of the fire on the Methodist Book Concern, which stopped the fire on the east. This was built with the Balph style of fireproof floors, which floors are made of I-beams, between which are stretched wires and twisted iron strips similar to fence strips and about which a flat arch of concrete is laid. The upper stories of this building were the most exposed, and the floors exposed the worst sagged visibly. All partitions on these floors were made of expanded metal and plaster on wooden studding. These were complete wrecks. In this style of fireproofing, and others similar to it, it occurs to me that the sagging referred to and the consequential damage are important features to be considered.

I may add that the severe damage done in the Horne building, aside from the fact that a wall three-fourths of which was glass windows and, therefore, not fireproof, was exposed to the full broadside effect of intense combustion and large area, some 26,000 sq. ft., was due in no small degree to the fact that it had staircase openings from floor to floor unprotected, and what was worse, a large well-hole, 48 × 22 ft., which practically made the whole building a large smelting furnace, the flames having full power with the draft from basement to roof. What the effect of these conditions would have been on the Methodist Book Concern building may be conjectured; there is no other way of getting at it; and this fire, therefore, does not offer any other method of comparing the two forms of construction.

The Horne building, with its numerous glass windows, held its combustible contents, fully exposed to a rousing fire, like a great grid-iron, with the result that it is claimed there is no salvage whatever on the merchandise in this so-called fireproof building; whereas in the building of mill construction burned recently in St. Louis, there was a salvage of over $400,000, or nearly 60% of the value of the stock. My opinion is that if the windows of the Horne building had been protected with fireproof shutters, and if there had been no well-hole or open stairs to carry the flames from floor to floor, the damage to both building and stock would have been slight.

It is, also, my opinion that if the Methodist Book Concern building had stood in place of the Horne building, directly opposite the burned grocery, the result would not have been better, if so good.

It will be some time before the lessons of this fire will be fully understood, but if it has demonstrated any facts it has certainly demonstrated two, viz.: first, that window glass is not fireproof, and, second, that well-holes and stairways from floor to floor of fireproof buildings do away largely with the separating value of the floors themselves.

Yours respectfully,

F. C. Moore.

46 Cedar St., New York city, May 19, 1897.

P. S.—Since writing the above I have had an interview with Mr. Balph, who represents the floor referred to in the Methodist Book building known as the Columbian, and he advises me that Mr. Lockett is mistaken as to the sagging of the floors having been caused by the fire. Mr. Balph informs me that the two upper floors were sagged before the fire, and as a consequence of not having been put in properly, the span between the beams being 16 ft.—more than three times the span (5 ft.) recognized by the Board of Examiners for patent floors. I wish to do Mr. Balph the justice of letting his statement go side by side with Mr. Lockett's.—F. C. M.

FOUNDATIONS FOR THE BROOKLYN TOWER OF THE NEW EAST RIVER BRIDGE.

(With two-page engraving.)

The new suspension bridge which is to be built across the East River, connecting Grand St., New York, with Broadway, Brooklyn, will have the cables of the suspended channel span carried by two towers of steel frame construction, each tower resting upon two masonry piers extending to a height of about 23 ft. above mean high water. The foundations for the New York tower are already under contract. Proposals for the piers and pier foundations of the Brooklyn tower are now being invited (and will be received until June 9), and we present this week the drawings and descriptions of this work, taken from the official plans and specifica-

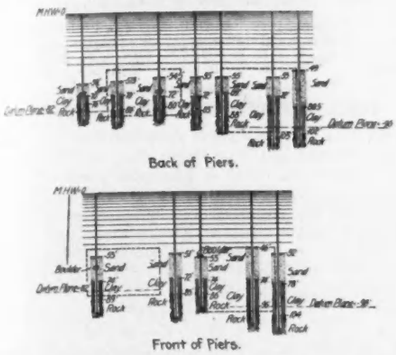


Fig. 1.—Results of Borings with Diamond Drill on Site for Piers for the Brooklyn Tower of the New East River Bridge.

tions, for copies of which we are indebted to Mr. L. L. Buck, M. Am. Soc. C. E., Chief Engineer of the New East River Bridge Commission.

The general plans of the adopted design for the bridge were given in our issue of July 30, 1896, and a perspective view of the design for the steel towers on the masonry piers was given in our issue of Aug. 20, 1896. The bridge will have a total length of 7,200 ft., with a suspended channel span of 1,600 ft., c. to c. of towers. The shore spans will not be carried by the cables, but will be supported by the masonry anchorages and the steel towers, with a central braced tower at mid-span. The approaches will be steel viaducts, with grades of 3% for the roadways and 2% for the tracks for the elevated railways. The suspension span will have a headway of 135 ft. for 400 ft. at the middle and 117 ft. at the towers. It will have two stiffening trusses 72 ft. apart c. to c. The bridge will be 118 ft. wide, having two roadways, two footwalks, four tracks for electric cars and two tracks for elevated railway trains. The masonry for the towers will extend to 23 ft. above high water, and upon the masonry will be erected steel towers, the saddles of which will carry the centers of the cables at a height of 335 ft. above high water. The four cables will be built up of straight steel wires of No. 6 B. W. G., in 19 strands, the finished diameter being about 17½ ins.

The line of the bridge is in almost a northwest direction, and the Brooklyn piers will be in the rear of the government pier-head line, between the wharves at the foot of South Fifth St. and South Sixth St. The results of borings with diamond drills on the sites of the caissons are shown in Fig. 1. The borings, and the apparatus for making them, were described and illustrated in our issue of Sept. 24, 1896.

The general design and dimensions of the two piers are shown in Fig. 2, by which it will be seen that the caisson for the north pier will be sunk about 14 ft. lower than that of the south pier.

Caissons.

Each pier will rest on a timber caisson sunk by the plenum-pneumatic process until it rests on bed rock. Each caisson will be 63 × 79 ft., and of such height that when sunk to final position its top will be 47 ft. below high water. Above the caisson will be a cofferdam to prevent the water of the river from obstructing the progress of the work on top of the caisson. The cofferdam will be removed after the completion of the pier. Fig. 3 shows the caisson, cofferdam and pier. Each caisson is to be completed to a height of 20 ft., and then launched, the construction being then continued while they are floating. Each caisson is to contain when launched about 35,600 cu. ft. of timber and 54 tons of iron, to weigh about 945 tons, and to have a draft (without false bottom) of about 11.4 ft. The following particulars are given on the drawings in regard to the sinking of the piers, but these are intended merely as an aid to bidders, and as showing the governing reasons for many points in the design:

South Pier.—The caisson is to be 39 ft. high when completed; to contain approximately 58,800 cu. ft. net of timber, and 86 tons of iron; to weigh (before the addition of any concrete), about 1,557 tons; and to draw about 15.5 ft. The depth of water at site of pier is now about 58 ft. at high water, and it is assumed that it may be increased to 60 ft. by the scour of the tide as the caisson approaches the sand bottom of the river.

A cofferdam 25 ft. high is necessary to safely land the pier on the river bottom, and the cofferdam is increased to a total height of 50 ft. to allow sinking to proceed independently of (and without waiting for) the construction of the masonry, and also to make it easy to keep the pressure on the cutting edge under perfect control during the sinking. The weight of timber and iron in the 39 ft. caisson, surmounted by 25 ft. of the cofferdam, is approximately 1,960 tons, and the draft of water without concrete is about 17.9 ft.

To land the pier on the river bottom, about 3,200 cu. yds. of concrete will be needed, and this concrete (in order to render the caisson above the roof more watertight and to keep the weight as long as possible off the middle of the roof and over the cutting edge) may be required to be so placed on the roof and around the sides as to leave a central well, to be afterwards filled with the balance of the concrete, about 860 cu. yds. To sink the pier through sand to clay, 72 ft. below high water, will require the balance of the concrete and about 600 cu. yds. of stone masonry. To sink the pier through clay and rock to its final position at 86 ft. below high water will require the weight of about 4,000 cu. yds. of stone masonry in addition to the 600 cu. yds. above. About 1,000 cu. yds. more stone masonry is needed to bring the pier up to the high water level; and about 2,155 more to bring it up to its finish, 23 ft. above high water, a total of 7,755 cu. yds.

A portion of the cutting edge in its final position will be about 2 ft. above the rock (Fig. 1). All clay must be removed from above the rock within the outer horizontal lines of the cutting edge, and the rock may be required to be worked into rough horizontal steps.

North Pier.—The caisson is to be 53 ft. high when completed; to contain approximately 74,700 cu. ft. of timber and 98 tons of iron; to weigh (without concrete) approximately 1,965 tons, and to draw about 17.9 ft. of water. The caisson is surmounted by a cofferdam 50 ft. high, for the same reasons as for the south pier, though only 11 ft. of cofferdam is necessary to land this pier safely on the river bottom in the assumed 60 ft. of water. Should the south pier be sunk first, it is probable that there will be no scour at the north pier, and that the depth of the water will be much less than 60 ft. The weight of timber and iron in the 53 ft. caisson, surmounted by 11 ft. of cofferdam, is approximately 2,140 tons; and the draft of water without concrete, about 19.1 ft.

To land the pier on the river bottom, in the assumed depth of 60 ft. of water, about 3,100 cu. yds. of concrete will be needed. This may be placed as described for the south pier, leaving a central well to be afterwards filled with the balance of the concrete, about 2,940 cu. yds. To sink the pier through sand to clay, 73 ft. below high water, will require the weight of about 1,500 cu. yds. of concrete in addition to the 3,100 cu. yds. above. To sink the pier through clay and rock to its final position, 100 ft. below high water, will require the weight of all the balance of the concrete, and of approximately 2,300 cu. yds. of stone masonry. About 3,300 cu. yds. more stone masonry is required to bring the pier up to high water level. The balance of the stone masonry, between high water level and its finish, 23 ft. above, is about 2,155 cu. yds.

As in the south pier, a portion of the cutting edge in its final position will be about 4 ft. above the rock (Fig. 1), and all clay must be removed from above the rock within the outer horizontal lines of the cutting edge, and the rock may be required to be worked into rough horizontal steps.

The caissons are of timber, and the details of construction are shown in Fig. 4. The timber is to be good, sound, long-leafed southern pine timber, free from rot, shakes, cracks and loose or decayed knots. It must be sawed square and of full dimensions. The timber for the walls and decks will be planed or dressed accurately on all sides; all other timber will be dressed on opposite sides to a uniform thickness for each course. The timbers will be fastened together by drift and screw bolts and well braced; they will break joint by at least 6 ft. All seams exposed to air or water pressure will be calked with oakum, covered with pitch. The interior of the working chambers will be painted. The cutting edge, or shoe, will be of oak. The horizontal courses are of timbers, 12×12 ins., the diagonal truss planks are 3×12 ins. and the sheathing consists of an inner layer of 3-in. tongued and grooved plank laid diagonally, and an outer layer of 3-in. plank laid vertically. The corners are protected by steel plates ¼ × 40 ins., 6 or 8 ft. high. The roof of the working chamber has an inner planking, 3 × 12 ins.; a course of 12 × 12-in. timbers; a layer of 3-in. tongued and grooved plank, a layer of 3 × 12-in. plank, and a top course of 12 × 12-in. timbers. The inner planking of the roof and sheathing is to be put on with the tongues and grooves wet with white lead or other approved material. The material sheet for caissons, Fig. 5, is not a part of the contract drawings, but was pre-

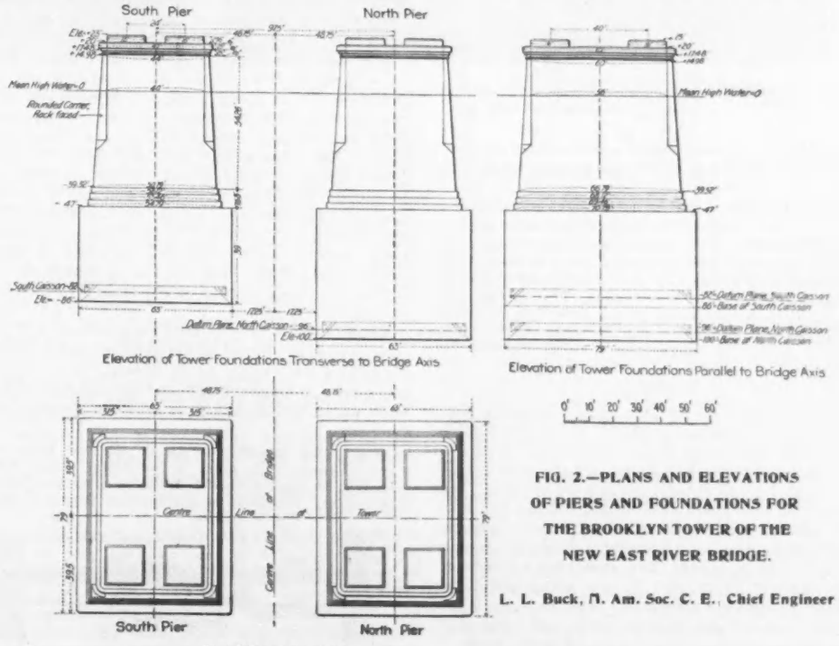

South Pier
North Pier
Elevation of Tower Foundations Transverse to Bridge Axis
Elevation of Tower Foundations Parallel to Bridge Axis
Plan of Tower Foundations
0' 10' 20' 30' 40' 50' 60'

FIG. 2.—PLANS AND ELEVATIONS OF PIERS AND FOUNDATIONS FOR THE BROOKLYN TOWER OF THE NEW EAST RIVER BRIDGE.

L. L. Buck, M. Am. Soc. C. E., Chief Engineer

pared as an aid to bidders, and explanatory of the official plans.

The drift bolts are to be of 1-in. round iron, cut from ordinary bars; without head and with blunt point, roughly made; the end merely rounded to remove all sharp edges. All drift bolts will be driven in ⅞-in. holes. These bolts are spaced 3 ft., 4 ft. and 5 ft. apart, as shown. The screw bolts will also be of 1-in. round iron, driven in tightly-fitting holes, with 6-in. cast washers, countersunk or plain. The 2-in. steel rods which tie the caisson horizontally and vertically have 12-in. cast washers.

The bed rock must be cleaned off for the whole area of the caisson, and all unsound or unsuitable rock removed until rock of a satisfactory character is laid bare. The surface may be stepped if necessary. The rock surface must then be thoroughly cleaned, and after inspection of the surface by the engineer the working chamber will be filled with concrete mixed as described below. For a depth of 6 ins. under the shoulder of the cutting edge and under all cross beams, cross walls and the roof of the chamber, mortar mixed in the proportions specified later on is to be used instead of concrete. Such mortar must be rammed hard into place, and is to contain only so much water that it will barely flush after ramming.

Concrete.

Concrete will be made with clean, screened, hard, angular, machine-broken limestone or trap rock of not more than 2 ins. largest dimension, mixed with smaller stone of the same kind not less than ¼-in. in least dimension, and with mortar in such quantity that when lightly rammed it will flush full all the interstices between the stone. The proportion of stone to mortar in the concrete in bulk shall not exceed six parts to three.

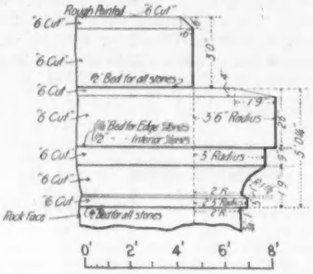


Fig. 8.—Details of Coping and Pedestal Blocks.

Portland cement and sand, in the proportions specified for mortar (see Masonry), shall be well mixed dry and then wet. The broken stone washed clean shall then be added while wet, and the mass thoroughly mixed by machine before being put in place. The least possible water shall be used, as determined by the engineer. The concrete shall be deposited in even layers of not more than 12 ins. in thickness, and well rammed until the mortar flushes to the surface. Each layer must be cleaned and moistened before the next layer is added.

Cofferdams.

The construction of the open cofferdam surmounting the caisson is shown clearly in Fig. 6. The outer courses of wall timbers are 8 × 12 ins. for the top section, 10 × 12 ins. for the middle section, and 12 × 12 ins. for the bottom section. The horizontal struts are 12 × 16 ins. for the two bottom courses, and 12 × 12 ins. for the upper courses, while the vertical and horizontal diagonal bracing is of 3 × 12-in. plank. The sheathing consists of two layers of 1¼-in. pine flooring plank laid diagonally (in opposite directions) and an outer layer of 3-in. tongued and grooved plank, laid vertically. The inner course is fastened by 20-penny nails, 1 per lin. ft.; the next by 8-penny cut nails, 1 per lin. ft.; and the 3-in. course by boat spikes, ⅝ × 7 ins., 2 per lin. ft. of plank. Inside the cofferdam there are to be 48 lines of vertical 1¼-in. iron rods, with turnbuckles and 6-in. washers. The corners of the cofferdam are tightened by Z-iron clamps of 1 × 2½-in. iron, 6 × 5 × 10 ins. No steel corner plates are used, but the corner joints are covered (after being calked) by a vertical 1-in. board, well nailed. The timbers are fastened together with drift bolts 1 × 30 ins., in ⅞-in. holes, these bolts being spaced 3 ft. apart in the horizontal wall timbers of the bottom section, 4 ft. apart in the middle section, and 5 ft. apart in the top section. The horizontal wall timbers are fastened to the vertical wall posts by drift bolts 1 × 22 ins. no screw bolts being used except in the anchor irons. The cofferdam is to be anchored to the caisson by 48 sets of anchor irons, as shown in detail in Fig. 6, there being one set opposite each of the inside vertical rods.

Masonry.

The stone for the piers is to be of granite throughout, unless the bridge commissioners permit the use of limestone for face work from below 4 ft. below low water, and for backing below the molding courses under the coping. The granite for the four pedestal blocks on each pier, for the coping, and for the face work to 4 ft. below low water is to be equal to Mill Stone Point or Maine granite. The granite for the remainder of the work is to be sound and of uniform quality. If limestone is permitted for use as noted above it must be equal to the best Kingston limestone, and must always be laid on its natural bed. The courses will be from 24 to 30 ins. thick, the thickest being at the bottom and the others decreasing towards the top. The bond must be such that no stone in one course will overlap those of the next course below by less than 15 ins.

The face stones below the coping will be rock-faced, with no depression below the pitch lines, and projections averaging 1½ ins., and not exceeding 4 ins., beyond the pitch lines. Bed and vertical joints of face masonry must not exceed ½-in. in thickness, but the vertical joints of the pedestal blocks and edge stones of the coping must not exceed ¼-in. The backing stones will be of the same thickness as the face stones of the same course. The coping, molding courses and pedestal blocks are to have the exposed faces dressed with six-cut work, and their beds and joints will be fine pointed. Face joints will be cleaned out to a depth of 1½ ins. and pointed with a mortar of Portland cement and sand, 1 to 1, driven in with a calking tool. Fig. 7 is a part side elevation of a pier, and Fig. 8 shows the details of the coping and pedestal blocks. On the top of the pier proper are four of these pedestal blocks for the columns of the steel tower, and the positions of these are shown by the plan, Fig. 9.

The face stones of the upper coping course will be secured to those of the next course below by dowels of 1¼-in. round steel, extending 6 ins. into each course. The stones of the upper course will be drilled through before setting, and after they are set the holes will be extended 6 ins. into the course below. A small quantity of mortar will then be put in, the dowel dropped in and driven down, and the hole filled with mortar well rammed. This arrangement is shown in Fig. 10. The joints of the lower coping course will have cramps of 1-in. square steel, 16 ins. long, cast to the shape shown in Fig. 11. These cramps will be sunk into the tops of the stone, as shown.

All the mortar (except that for pointing) will be composed of one barrel of Portland cement (weighing 375 lbs. net.) to 8½ cu. ft. of sand. The cement and sand will be mixed dry, and then enough clean fresh water will be added to give the proper consistency.

Cement.—The cement must be an approved brand of Portland cement, fully equal, in the opinion of the engineer, to O. F. Alsen & Sons' best quality of German Portland cement. Briquettes of neat cement, exposed to the air for 24 hours and immersed in water for 6 days, must have a tensile strength of at least 350 lbs. per sq. in. Briquettes of 1 part cement to 2 parts of dry sand (by weight), exposed to the air for 24 hours and immersed in water for 6 days, must have a tensile strength of at least 150 lbs. per sq. in. Pats of neat cement set in air and then immersed in water must show no checks or cracks.

All cement must be freshly and finely ground. At least 90% must pass through a sieve of 10,000 meshes per sq. in. The test for tensile strength will not be considered final or conclusive in determining the character of any cement, or as compelling the acceptance of a cement otherwise objectionable in the opinion of the engineer. All cement must be carefully handled and protected from the weather at all times.

Sand.—All sand must be clean, coarse, sharp, and free from mica. For the masonry, it must be passed through screens having openings ⅛-in. square. For the concrete, it must be free from stones and large pebbles.

The approximate quantities of materials in the work are as follows:

Materials for Piers for Brooklyn Tower; New East River Bridge.

		South Pier.	North Pier.
Excavation:	Sand	3,400 cu. yds.	4,080 cu. yds.
"	Clay	2,230 " "	4,170 " "
"	Rock	390 " "	910 " "
Caisson:	Timber	58,800 cu. ft	74,700 cu. ft
"	Iron	86 tons.	98 tons.
"	Concrete abv roof.	4,060 cu. yds.	6,040 cu. yds.
"	Concrete belw roof	1,080 " "	1,205 " "
Stone masonry		7,755 " "	7,755 " "

Cofferdam (One for Each Pier).

	Sections			
	Bottom, 17 ft. high.	Middle, 17 ft. high.	Top, 16 ft. high.	Total, 50 ft. high.
Timber	11,100 cu.ft.	10,000 cu.ft.	7,900 cu.ft.	29,000 cu.ft.
Iron	14 tons.	10 tons.	8½ tons.	32½ tons.

TESTS OF FIREPROOF FLOOR CONSTRUCTION.

On May 20 the tests of fireproof floor constructions by the Building Department of New York city, previously noted in Engineering News,* were continued with a comparative test of a hollow tile floor and the standard wire and plaster of Paris floor of the Metropolitan Fireproofing Co., of New York city. As in the previous tests conducted by the Building Department the tests were made by means of wood fires burned inside of brick buildings 12 × 15 ft. inside measurement, across the tops of which the floors had been built in the usual manner of building construction. Lengthwise of each building were placed four 10-in., 25-lb. I-beams, the two outside beams resting wholly on the side walls of the building, but the two inside beams having only their ends resting on the end walls of the building. These beams were spaced 4 ft. apart c. to c., with the intervals between spanned in one building by a tile floor and in the other by the Metropolitan floor. Both floors were built by Mr. Geo. B. Post, Architect, of New York city, for the Metropolitan Fireproofing Co.

Figs. 1 and 2, drawn from sketches furnished us by the Metropolitan Fireproofing Co., show in a general way the construction of the two floors. The various dimensions are given on the drawings. For the Metropolitan floor the sleeper fill was concrete, consisting of 1 part Portland cement, 2½ parts sand and 8 parts cinders. The plaster ceiling was hung from the bottom flanges of the I-beams, and about 2 ins. away, and was composed of lime mortar and Roebling wire lath. Its thickness was ¾-in. For the other floor 10-in. hard-burned tile blocks were used, set in Atlas Portland cement mortar, 1 part cement and 2½ parts sand, with ⅝-in. joints. On top of the blocks was a 2-in. concrete plate and also a 2-in. sleeper fill of concrete, composed of 1 part Portland cement, 1 part sand and 8 parts cinders. Both floors were loaded by the New York Building Department on May 19 with a uniform load of 150 lbs. per sq. ft. extending over the center panel, and both floors were put in on May 13.

The fire was started in both buildings at 10:22 o'clock a. m., and quenched at 3:22. o'clock p. m.,

Fig. 1.—The Metropolitan Fireproofing Co.'s Fireproof Floor, Tested May 20 by the New York Building Department.

Fig. 2.—The 10-in. Hard Tile Floor Tested May 20 by the New York Building Department.

making the duration of the fire test just five hours. As shown by the two Uehling & Steinbart pyro-

* Previous tests of fireproof floors made by the New York Building Department have been described in Engineering News as follows: John A. Roebling & Sons Co., Sept. 17 and Nov. 5, 1896; Fawcett Ventilated Fireproof Building Co., Sept. 17, 1896; Central Fireproofing Co., Oct. 1, 1896; Rapp Sheet Metal Works, Oct. 29, 1896; G. H. Thomson, Nov. 12, 1896; Macabe Bros & Co., Nov. 12, 1896; Columbian Fireproofing Co., Jan. 7, 1897; Gustavino fireproof floor, April 8, 1897; Manhattan Concrete Co., April 22, 1897; American Fireproofing Co., April 22, 1897; Central Expanded Metal Co., April 29, 1897.

meters the temperatures to which the floors were subjected were as follows:

Time.	Tile floor.	Metropolit'n floor.	Time.	Tile floor.	Metropolit'n floor.
	0	0	12.30 p. m.	1,856°	1,875°
10:22 a. m.	1,625°	1,660°	1:00 "	1,856°	1,875°
10:45 "	2,050°	1,900°	1:30 "	1,600°	1,800°
11:00 "	1,975°	1,850°	2:00 "	1,675°	1,700°
11:30 "	1,850°	1,875°	2:30 "	1,900°	1,650°
12:00 m.			3:10 "	1,900°	1,800°

At 3 o'clock the total deflection of the Metropolitan floor had been 0.34-in. and of the tile floor, 1.87 ins. The quenching was accomplished simultaneously by two 60-lb. pressure streams from a single engine directed against the under side of the floors for 15 minutes, and then water was poured on the tops until they were flooded.

An examination of the two floors after the water test showed that on the Metropolitan floor the plaster of the ceiling was all gone except in the corners where the fire stream had not struck it, and that the wire lath was broken through in places. The openings left by the breaks in the wire lath amounted to about 10% of the total area of the ceiling. The beam flanges were bare where the full force of the stream had struck, and the bottom part of the floor plate had been washed away so as to expose the wire suspenders at the center. The plaster on the side walls of the building was torn off wherever the stream struck it. On the tile floor the bottom coating of plaster was washed off, except in the corners where the full force of the stream had not reached. This left an open crack from ½-in. to 1 in. wide along the centers of the lower flanges of the beams where the protecting tile did not meet. In the center panel a little to one side of the middle both transversely and longitudinally the bottoms of four tiles were broken off and a little to one side of this break the bottoms of two tiles protecting the beam flange were gone, leaving the metal bare. Smaller breaks, taking off parts of the bottoms of the tiles, were shown in three or four places. The plaster on the side walls was gone wherever the stream had struck it.

Following the two fire tests a test was made by Mr. Geo. Hill, M. Am. Soc. C. E., to determine the strength of the expanded metal and concrete floor of the Central Expanded Metal Co., tested April 23, as noted in Engineering News of April 29. At the center of the middle panel, transversely, and about 4 ft. from the end, longitudinally, pressure was applied on an area of 1 sq. ft. by means of a hydraulic jack. This test was, of course, made on the floor which had undergone the fire test of April 23. At a pressure of 13,000 lbs. the floor cracked about 19 ins. from the center of pressure and shortly after a second crack followed 15 ins. from the center. A most notable feature of this test was the action of the expanded metal. This snapped strand by strand and at each fracture the break was recorded by a fall in the pressure gage. The test indicated very clearly the valuable part which the expanded metal plays in giving strength to this floor.

A LOCOMOTIVE TURNTABLE OPERATED BY ELECTRIC POWER; MILWAUKEE SHOPS, C., M. & ST. P. RY.

We illustrate herewith an electric motor for operating a locomotive turntable which has been in successful operation at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Ry. for some months. These shops are, as is well known, located at an important division point, where expedition in handling locomotives in and out of the roundhouse is very desirable. Every 24 hours 176 locomotives, or seven per hour, are turned on the roundhouse turntable, and the gain of a few minutes, even, at each operation means a material saving in expense daily. Formerly, when the table was turned by hand, four men were required and the average time spent by them at each turning was 20 minutes, or 5 minutes each. For the entire 176 turnings, therefore, 59 hours of labor were required. At 12½ cts. per hour, the wages paid engine wipers who also operated the turntable, the cost of operating was $7.37 per day.

In this calculation, it is assumed that the men used in turning the table attended to the wiping of engines when they were not engaged at the table, otherwise the saving would have been greater. The estimate of 5 minutes required for each man of the gang away from his work each time the engine was turned is a conservative one, for, as a matter of fact, during the busy hours of the day the men were at the table practically all of the time.

With the introduction of the electric motor, the labor force was reduced to one man, day and night, each 24 hours, making a saving of 35 hours or $4.37 per day in labor. At the Milwaukee shops this was not quite the saving which resulted, as it was not considered advisable to drop any of the wipers who could be used to good advantage on their regular work, but an actual reduction of $3 per day was made in the following manner, without reducing the number of wipers: Working on an eight-hour basis, under the old conditions, it was necessary morning and night to retain three men four hours, each change of shift, or altogether 24 hours of extra labor per day. At 12½ cts. per hour, this amounted to $3 per day, as stated above.

The cost of the electric power has of course to be deducted from the above to get the net saving. According to figures obtained from the railway company, the average power required to turn the table with one locomotive is ½ HP. per hour. Assuming 6 lbs. of coal per horse power per hour, and the cost of coal per ton as $2, we get a cost of 0.3 cts. for fuel for turning one locomotive, or for turning the total 176 locomotives per day a cost of 53 cts. for fuel. With the motor the table can be turned one complete revolution, including starting, when unloaded, in 30 seconds, and when loaded with a 100-ton locomotive and tender, in 45 seconds.

Turning now to the mechanical features of the device, it will be seen from the illustrations that they are very simple. A one-wheel truck operated by an electric motor is attached to one end of the table by means of a flexible spring connection, and runs on the circular track in the pit. The necessary traction is obtained by the weight on the driving wheel of this cart, which is about 3,000 lbs. Fig. 1 shows the turntable with the motor attached, and Fig. 2 is an enlarged view of the motor alone. The motor is of the "series-reversible" type, and of 10 HP. capacity, and is entirely inclosed by a waterproof casing. From the motor pinion the power is conveyed to a spur wheel on an intermediate shaft, which also carries a pinion meshing with the spur wheel on the driving wheel shaft. To prevent shocks in starting and reversing the motor is flexibly suspended on the truck.

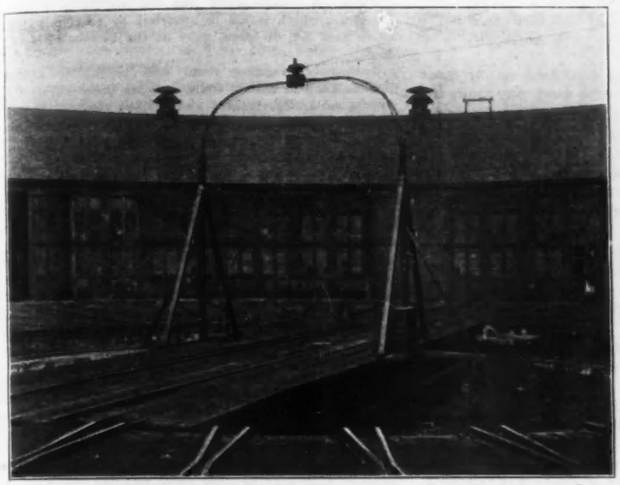


FIG. 1.—TURNTABLE OPERATED BY ELECTRICITY, MILWAUKEE SHOPS, C., M. & ST. P. RY.

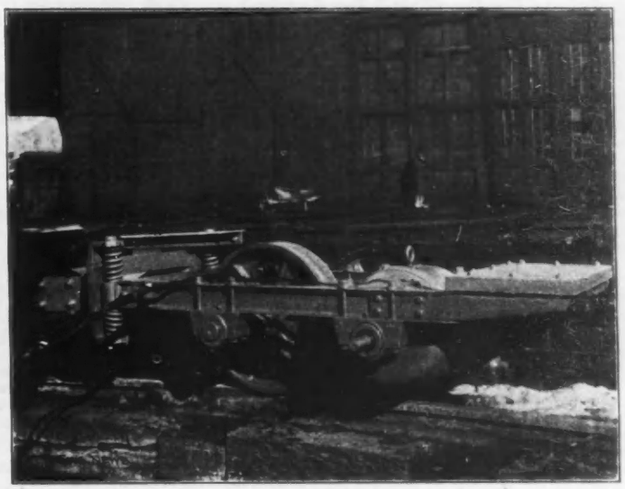


FIG. 2. ENLARGED VIEW OF ELECTRIC MOTOR FOR C., M. & ST. P. RY. TURNTABLE.

Power for operating the motor is conveyed by wires, which are brought overhead to a light arch spanning the table at the center, as shown by Fig. 1. The means for operation consists of a resistance or starting box, which is located at the center of the table in this particular case, but which may of course be placed on the truck if it is desired. This resistance box enables the table to be turned in either direction by the movement of the handle, either forward or back of the center.

It will be seen that this device requires no change in the table or in the pit, and can be applied to any table with a very small amount of material and labor. As nearly all locomotive shops now contain an electric light dynamo, the question of obtaining power is not a serious one. Of course the saving effected by the use of the motor in the case described would not be realized at every place, but where the turntable has a large amount of work to do, as in shop and terminal yards, the possibilities are that electric or some other convenient power can be used to advantage in place of hand labor.

The device illustrated was designed by Mr. Geo. Gibbs, M. Am. Soc. M. E., Mechanical Engineer, Chicago, Milwaukee & St. Paul Ry., and the motor and apparatus were manufactured by the Gibbs Electric Co., of Milwaukee, Wis. We are indebted to Mr. Gibbs for the information from which this description has been prepared.

THE NEW WATERWAYS AND LAND RECLAMATION AT SEATTLE, WASH.

The development of the city and harbor of Seattle, Wash., includes the construction of canals to connect Puget Sound with Lake Washington (which is above and behind the city), and the fill-

ing of the tide flats with material excavated from the canals, or waterways" as they are termed. A general description of the project of the Seattle & Lake Washington Waterway Co. was given in our issues of March 15 and July 12, 1894, and Jan. 24, 1895, while in the "Notes of a Transcontinental Trip," in our issue of Dec. 31, 1896, we gave a summary of the progress of the work with a map of the proposed alteration of the harbor by filling in the tide flats. We have recently received from Mr. Ernest E. Ling, Secretary of the Seattle Chamber of Commerce, a letter written to him by Mr. Eugene Semple, President of the company, and ex-Governor of Washington, from which we take the following extracts:

The enterprise is unique in this, that while it is a gigantic undertaking, the outlay in its execution reaching up into several millions of dollars, yet, as forcibly stated by the Chief Engineer of the company, Maj. Thos. W. Symons, of the U. S. Engineer Corps: "It is accomplished without any tax on existing properties, but rather to the benefit of existing properties." The entire cost of the excavations, including a cut through a hill 120 ft. high at one point, is charged against the embankment on the tide flats, and the work is not subject to the usual hazards of great undertakings, the values that are to sustain the charge being created by the operation. The proposition is so flexible that a balance between the cuts and fills can be formed upon any basis that may become necessary from time to time. The lands which are to sustain the charge are worthless in their present condition, with from 12 to 18 ft. of water flowing over them at each high tide, and they are changed by the operations of the waterway company into properties rating in value from $75 to $200 per front foot. Owing to the use of the latest appliances in machinery, and owing to the proximity of the land to be filled to the source of materials, the cost of the solid embankment is less per acre than that of a substantial wharf upon which existing frame buildings at Seattle are imposed. The waters from the Duwamish River, which flow into the two waterways, reinforced by the fresh water outflowing from the lake through the canal, will prevent the depredations of the teredo and increase the life of a wooden wharf at Seattle, from 18 months, as now, to 30 years.

The grade of the embankment has been fixed at only 2 ft. above the extremest high tide, while the grade of the existing streets of the city is about 16 ft. higher. This admits of a plan proposed by City Engineer Thompson for an overhead accommodation for all street traffic, and a subway for the railways, the intention being to have the wharves on the waterways two stories in height. Freight interchange between ships and railways will be on the lower level, and freight intended for delivery in the city will be delivered from ship's tackles to the upper decks of the wharves, whence it can be hauled to its destination free from interference with the railways.

When these plans are executed, Seattle will have ideal railway terminals, as well as an ideal harbor. To increase the facilities for the accommodation of commerce, the Seattle & Lake Washington Waterway Co. intends to construct, in the vicinity of its locks, a gravitation dry dock, capable of handling vessels 500 ft. in length, 30 ft. draft and 80 ft. beam.

As illustrating the advantages to Seattle of the work now in progress, it may be stated that the Centennial Flouring Mill Co., of Spokane, which has concluded to erect a mill with a capacity of 1,000 barrels per day, was able to select an eligible situation on the tide flats, far in advance of the completed fill, and the Seattle & Lake Washington Waterway Co. has undertaken to fill up an island for the site, so that the construction of the mill buildings may commence at once, the intention being to connect the island with the mainland by a causeway for temporary use during the considerable time that will be required to include the mill site in the permanent embankment.

It is intended to dislodge the material in the hill section by the use of water under high pressure, after the fashion of the hydraulic mining of California, and to transport it by the returning water to the embankment on the flats. These works, when installed and placed in operation will be worth traveling many miles to see, as they will be on a most gigantic scale.

LOW BIDS FOR CAST-IRON PIPE have been received in many cities recently, the lowest, we think, having been opened by the water-works trustees of Youngstown, O., May 18. The contract at Youngstown was awarded at $14.60 a ton, with special castings at 1¾ cts. a lb., the other bids for pipe ranging from $14.87 to $15.85 a ton.

CAR LIGHTING BY ELECTRICITY ON THE ATCHISON, TOPEKA & SANTA FE RY.

The Moskowitz system of car lighting by electricity is to be introduced on the Atchison, Topeka & Santa Fe Ry., and a contract for equipping 50 cars (including passenger, private, mail and baggage cars) has been awarded to the National Electric Car Lighting Co., of 30 Broad St., New York city, of which company Mr. Max Schmidt, M. Am. Soc. C. E., is Engineer and Manager. The Moskowitz system was described and illustrated in our issue of Oct. 29, 1896, and is a combination of dynamo (driven from one of the car axles) and two sets of the company's special storage batteries, which are manufactured at its own works at Newark. No direct current is used, but the lights are supplied from the two batteries alternately, one being charged while the other is in service, and the change from one to the other being effected automatically. One ordinary day car equipped with this light has been in operation for some time on the Pennsylvania R. R., as described in the article above referred to, and a chair car has been in continuous service on the Atchison, Topeka & Santa Fe Ry. since last November, or for about six months. The Pennsylvania R. R. car has recently been equipped with the improved apparatus, described below, and as the car is run on night trains making long runs in some parts and frequent stops in others, the lighting system is given a good practical trial. The cost of operation is said to be remarkably low.

In the original system, as described in our issue of Oct. 29, 1896, two belts were used, one from the axle pulley to the countershaft, and one from the countershaft to the dynamo. In the improved system adopted for the Atchison, Topeka & Santa Fe Ry. (and already installed on the Pennsylvania R. R. car) only one belt is used. The dynamo and the countershaft (which latter is carried in spring bearings to give a uniform tension on the belt) are on opposite sides of the axle, and the belt assumes a triangular form. It passes up from the axle pulley to the countershaft pulley, then across to the dynamo pulley and back down to the axle pulley again, its contact with this pulley being on an arc about 12 ins. long. The belt is of camel's-hair, as this material is not affected by rain or snow, and one belt has already made a run of 43,000 miles on the chair car of the Atchison, Topeka & Santa Fe Ry. This car has run over 56,000 miles, and it is expected that the belt will run for 45,000 miles before it will become so worn as to require to be renewed. A special feature of the belt is the joint. Up to about four months ago the ordinary lap-joint was used, as commonly adopted for shop use. In the new joint, the ends of the belt are turned up and tightly clamped between steel plates or washers and jam nuts. The advantage of this connection is that the joint itself does not come in contact with the pulleys, and will, therefore, outlast many belts, since the metal fastenings are not worn by contact with the pulleys, and the fastenings are such that the tension of the belt tends to tighten rather than to loosen the joint. Before this connection was introduced, belts would occasionally break and be lost, but not a single belt has been lost or broken since the new connection was put in service.

The equipment of the 50 cars will be completed in about six months, and the company will shortly establish new and larger works having a capacity of one car equipment per day or 26 equipments per month.

HYGROMETRIC PROPERTIES OF COAL.

By R. C. Carpenter, M. Am. Soc. M. E.†

The investigation described in the following paper was undertaken for the purposes of ascertaining the relative qualities of various coals when in the same physical condition with reference to absorbing moisture from the atmosphere. The investigation was suggested by noticing the losses or gains which took place in different samples of coal corresponding to the changes in the humidity of the atmosphere.

Two lines of investigation were undertaken: First, a number of samples of different coals were reduced to a uniform physical condition by grinding or powdering; were then thoroughly dried, and afterward simultaneously exposed to a saturated or nearly saturated atmosphere, for a period of from six to eight days as required, to obtain constant weight. The weight of moisture was determined by taking the difference between the first and final weights, and this result was checked by thoroughly drying and reweighing.

*Abstract of a paper presented at the Hartford meeting of the American Society of Mechanical Engineers.

†Professor of Experimental Engineering in Sibley College, Cornell University.

Second, an investigation was made to determine the effect of the size of particles upon the power to absorb moisture; the investigation being similar in nature to that previously described.

The method of drying in all cases was the same. The coal was heated to a temperature of from 220 to 230° F., and maintained in that condition for one hour. Results indicate a very great difference in the absorptive power of different coals when in the same physical state, but show, however, a striking similarity in this respect of coals which are known to possess similar qualities and are from the same geographical districts. Thus, the various samples of anthracite absorbed amounts of moisture which varied from slightly under 5 to slightly over 6% of the weight of the dry coal; the coking coals from Western Pennsylvania absorbed amounts which varied from slightly less than 1% to about 3%; the Western bituminous coals absorbed from 8 to 14%. Pocahontas absorbed an amount greater than the anthracites.

The first investigation seemed to indicate that, independent of the physical condition, different coals vary greatly in their hygrometrical properties, and that with few exceptions, the power of absorbing and retaining moisture is less as the calorific value is greater.

Thus the results show that the maximum amount of moisture, which would be absorbed by coals powdered so as to pass No. 80 sieve, were on the various tests as follows:

Anthracite, ranging from 4.66 to 6.37%, averaging 5.60%; Eastern coking coals, ranging from 0.69 to 3.16%, averaging 1.92%; Illinois and Indiana coals, from 4.65 to 14.10%, averaging 9.77%.

The effect of the size of particle is quite decided. The larger the particle, the less the weight of moisture which is absorbed. This indicates that the absorptive power is in part due to capillary action of the surface.

In the second investigation the pieces of coal were made as nearly equal as possible considering their irregular shape of definite sizes, having diameters respectively 1 in., ½-in., ¼-in., and powdered so as to pass through sieves of 60 to the inch. In these experiments there were used two samples of anthracite coal, one obtained by breaking up pieces of egg coal, the other pieces of pea coal; two specimens of bituminous coal, one an Illinois coal and the other a Cumberland coking coal. The results of this investigation show an increase in absorptive power as the size of the particle is diminished. The results are slightly irregular, due probably to irregularities in the samples selected, but the variation, however, is no more than would probably be found in the selection of samples.

In connection with the drying of coals at temperatures above the boiling point, a number of experiments were made to determine whether there was any sensible loss of volatile matter, but so far as could be determined by repeated trials, alternately drying and moistening and by varying time of drying from one to three hours, no loss of volatile matter could be detected, and it seems exceedingly probable that no loss of importance occurs at temperatures below 300° F.

For this reason it would seem entirely safe to use this method of drying coals in testing boilers, as it is easily applied, and has given very satisfactory and uniform results for the writer whenever used. The following table gives the results of observations on the effect of the size of the particle on the absorptive power. (The table is condensed here.—Ed.) The observations were taken by C. E. Houghton, M. E., and E. C. Sickles, M. E.:

Per cent. moisture gained by different sizes of coal:

	Gain of moisture in 35 days.			
	Size of coal.			
Kind of coal.	1	½	¼	Fine.
Anthracite egg	1.394	2.028	2.55	5.93
" pea	0.617	0.664	1.31	1.587
Cumberland	2.17	3.765	5.612	6.424
Illinois	4.55	5.801	5.26	9.39

ELECTRIC LIGHTING OF A CEMENT QUARRY.

The cement quarries and mills of the F. O. Norton Cement Co., at Binnewater, N. Y., situated in the Rosendale cement district, about seven miles from Kingston, have recently been equipped with an electric lighting plant, which has some features of interest. It is believed to be the first instance in which electric light has been used in cement quarries in this country. The deposit from which the Norton (natural) cement is made is bluish gray magnesian linestone or cement rock found in strata of between 14 and 17 feet in thickness, and of various inclinations, constituting the hills along the valley of the Rondout Creek.

The stone is quarried in the ordinary manner, being taken out in separate galleries, corresponding with the various strata or layers. There are two such strata in the Norton quarries available for making a high grade cement. These are separated by a middle layer which contains impurities and is not used for producing first-class cement.

About 4½ barrels of cement are made from one ton of rock. At the quarries about 1,600 barrels

of cement are manufactured per day, running 300 lbs. to the barrel. The galleries have 50 ft. face, and are upheld by pillars 20 ft. square and 30 ft. apart.

The power plant consists of four horizontal tubular boilers, furnishing steam at 100 lbs. pressure to a 750-HP. Harris-Corliss cross-compound, slow-speed engine. This power is used to operate 16 cracker mills, the crushers, etc.

The electric plant consists of a 30 K. W. alternating current incandescent dynamo, manufactured by the General Electric Co. This machine is driven by a 10 × 12-in. horizontal Ball engine.

There are now installed 103 incandescent lights, lighting the kiln shed, the mills, the packing rooms, the shipping rooms, and various other departments of the factory.

The quarries are lighted by 40 incandescent lamps and 14 arc lamps. The current is used at a pressure of 300 volts, being reduced by transformers to the necessary voltage for arc and incandescent lamps. Each arc lamp is operated by its individual transformer. In addition, one or two incandescent lamps on flexible cords, protected by wire cages, are operated from the same transformer when required.

Arc lamps are also connected by flexible cords to the transformers which are placed back of the nearest pillar to the face of the gallery. The lamps are supported from the roof of the gallery by means of ropes and pulleys, and give a most satisfactory general illumination for the whole work. A suspended light is used by the men handling the drills and shoveling the broken stone in the loaded cars. Incandescent lights fixed in position are placed at tht main platforms and turn table, while lamps for the purpose of general illumination are also placed at moderate intervals along the galleries now being operated. When the blasts are fired, the lamps are unhooked and taken back behind the pillars.

The electric light installation has entirely done away with oil lamps, the use of which in many cases rendered work almost impossible, since it was necessary to place the drills at the very top of the gallery on a shelf sufficiently below the roof for the erection of the drill. In the days of oil lamps the room was so filled with smoke and fumes that the men could only work there for a short time.

The circuits are carried into the quarries from the power house, a distance of about 400 ft. in one direction, and 1,500 ft. in the other. They are carried along the galleries, being fastened to insulators fixed to plugs driven into holes in the roof of the worked out galleries. From various points main loops are carried to the galleries where the work is going on.

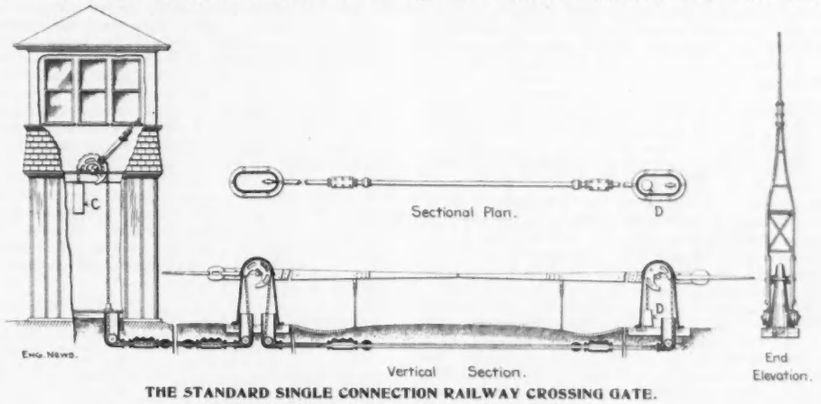
The present electric plant is only working to about half its capacity and lights will be added as the work is extended.

THE "STANDARD" RAILWAY CROSSING GATE.

The accompanying cut shows a railway crossing gate for which several claims of ease and simplicity of operation and economy of maintenance are made by the builders. These gates have been used by the Pennsylvania, Grand Trunk, Michigan Central and other railways, and are manufactured and sold by the Standard Railway Gate Co., of Saginaw, Mich. As will be noted from the drawing both arms of the gate are operated by a single connection and from one lever. Two levers, therefore, serve to operate both of the gates used at an ordinary crossing, and by means of a special locking device the two levers may be operated as one when desired. It will be noted further that the levers are bolted to the chain wheel and that the notched segment for locking is bolted to the floor and is separate from the lever and wheel. In a letter from the manufacturers the following additional claims of advantages are given:

The simplicity of these gates is shown by the drawing. They are operated with what is termed the single connection, the purpose of the weight C in the tower and the weight D in the post being to avoid the use of the return line of pipe. In these gates, where there is one line of pipe, others have from two to four, no other gate, operated either mechanically or by air, having less than two. This reduction in the number of underground pipes is very desirable in the protection of the ordinary railway crossing, but much more desirable where a great number of gate arms are to be handled, some at a considerable distance from the tower.

Sometimes it is asserted as an argument against mechanically operated gates that the wire inside the pipe is likely to freeze up in the winter, while the pipes of air gates have nothing in them to freeze. The company claims, however, that the mere presence of a wire in a pipe can neither cause water to leak into it nor cause condensation on its inside surface, and that should either surface water or water of condensation collect inside and freeze up, it would as quickly choke off a column of air as it would hold a wire. It certainly does not appear that there would be any discrimination on the part of the water as to the kind of a pipe it should enter, whether it was for air or for a wire, or that there should be any discrimination on the part of the moisture in the air as to the pipe in which it should condense. The company claims, therefore, that in every railway crossing gate, whether operated by purely mechanical means or by air, that everything depends upon the number of the pipes, whether they are large or small, and the care taken in laying them. In the single connection gates the gate arms are counterbalanced and the weight C in the tower is counterbalanced by the weight D in the post, consequently to move the levers in either direction requires the same force.



THE STANDARD SINGLE CONNECTION RAILWAY CROSSING GATE.
Standard Railway Gate Co., Saginaw, Mich., Builders.

THE FIRST ANNUAL MEETING OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION.

The meeting of the American Foundrymen's Association at Detroit, May 11 to 14, was a notable event in the history of the foundry business. Representative men in the industry were present to the number of about 300 from about 80 cities and towns in the United States and Canada. The technical papers read and discussed were of a class that would do credit to any of our national engineering societies, and a highly interesting exhibit was made of foundry supplies and machinery. The scope of the association is wider in some respects than that of the engineering societies, for it admits of the discussion of questions of business and social economics, including the labor question, strikes, apprenticeships, the hours of labor, wages, etc. The efforts of the membership of this association to do something practical in regard to these questions will be watched with interest by manufacturers in general, and should these efforts prove in any degree successful, the result will be an important step in the evolution from the present frequent conflicts between labor and capital to a state of harmony. Such an evolution is perhaps more needed now in the foundry business than in almost any other, but if the foundrymen can do anything to improve the existing relations between employers and employed, their example cannot fail to be of benefit to many other trades.

A remarkable instance of the tendency of the foundry owners to progress in the direction of a better understanding with their workmen is shown in the addresses of the president of the Association, Mr. Francis Schumann, President of the Tacony (Pa.) Iron & Metal Co., and of Mr. Martin Fox, President of the International Iron Molders' Union. We quote from Mr. Schumann's address as follows:

Lessening the hours of labor seems to me the most vital question available for immediate application toward the welfare of all, whether employer or employee. Instead of laboring night and day for short periods to meet spasmodic demands, is it not wiser to so adjust the labor as to bring about the equal distribution of work among the many? Is not the lessening of the hours of labor one of the most vital elements to correct the disturbances between supply and demand?

The cultivation and maintenance of knowledge and skill on the part of those practicing our art is a question paramount in importance to any that may come before us. The adoption of a wise and uniform system of apprenticeship is a necessity generally admitted, and it should receive your careful consideration and action. Equally important is the adoption of methods that will promote intimate and amicable relations between employer and employee—the golden rule as a guide will readily suggest practical and effective means for bringing about beneficial results.

Mr. Pfahler, of Philadelphia, in introducing Mr. Fox, said that he had not met a manufacturer in over two years who was not in favor of a reduction in the hours of labor. We quote the following report of Mr. Fox's address from the "Iron Trade Review:"

He granted that the change could not take place without a corresponding reduction in wages, though if there were the possibility of enforcing the new regulation simultaneously all over the country he would say that wages should remain as at present. The evils of the present plan of spasmodic operation of works; the crowding of a year's product into a few months, in some cases; the large number of unemployed men, able and willing to work, who would get places if the work day were shortened; the increased efficiency of labor, under shorter hours (though with his knowledge of the physical strain already upon the molder, he did not lay great stress upon this argument, as applied to that employment); the enormous increase in the effectiveness and productivity of labor in this age of machinery, forcing upon us the problem of overproduction, because no reduction has been made in working hours—these and other considerations were urged by the speaker in a clear and logical way that made a good impression upon the convention.

That the ideas of the foundrymen concerning the labor question are not academic but are intensely practical is shown by the fact that the association has a "Defense Committee" and that it is proposed to form within the lines of the association an organization for the purposes of defense and for the avoidance of labor troubles. The idea seems to be that which now controls the nations of the world, viz., that the best way to promote peace is to have a strong navy and impregnable forts on the coast. Among the suggestions made by the committee concerning the proposed organization are the following:

The object of the association should be the mutual protection of its members and the adjustment of all disputes with employees, with due consideration for the just interests of both parties to the controversy.

An emergency fund should be created by special assessments on the members, in proportion to the number of molders employed by each at the time such assessment was levied. This fund should be held intact, for the double purpose of having on hand, at all times, ample funds to meet any demand upon the association, and to create an added attraction, making membership more valuable as the fund increased.

Every member should be free to settle on his own responsibility any dispute arising in his shop, but, having once invoked the aid of the association, he should place the entire settlement in its hands and be required to abide by the decision reached.

In case of dispute, every reasonable effort to settle it without a strike should be made, and if the employees refused to consent and did strike, all the force of the association should be brought to bear to give assistance to the member whose shop was affected, either by procuring men to take the places of the strikers, or by compensating the member for losses incurred in defending the principles at stake.

The proposed organization is to be modelled after the Stove Founders' Association, which has been in successful operation for ten years, with results which are stated by the committee as follows:

Through the operation of this plan a bond has been formed so strong that, while the association has protected its members from unjust demands, it has inspired the employees with such a sense of the justice of their employers that it is now a fundamental principle to settle all disputes without the cost of a strike, and to adjust all questions of wages and methods by periodical conferences, in which all the conditions of the business are freely discussed and reason dictates the result.

In discussing the report of the Defense Committee, Mr. Henry Cribben, vice-president of the Stove Founders' Defense Association, said that the lines of operation of the latter were:

"First, to combine the manufacturers of stoves into a powerful and effective body so competent for defense that these organizations of employees will fear to provoke it; second, to improve the relations of employer and employee by inducing the material co-operation of those who now occupy a position of inert independence, it being easier to improve the environment by removing the inducement to do wrong than by cultivating sentiment, and, third, to educate all concerned and gradually formulate rules of action whereby disputes will be avoided."

On the last day of the meeting the Committee of Defense

reported that it had secured the signatures of a number of foundrymen who agreed to take the preliminary steps, at least, toward the proposed organization, and the committee was continued for another year with instructions to communicate its plan to the membership by letter.

BOOK REVIEWS.

MINING IN THE PACIFIC NORTHWEST.—A complete review of the mineral resources of Washington and British Columbia. With maps. Edited by L. K. Hodges. The "Post-Intelligencer," Seattle, Wash., 1897. Paper; 8¾×5¾ ins.; pp. 192. $0.50.

This is a reprint of articles originally prepared for the "Post-Intelligencer" by a member of the staff of that journal who personally visited the mining camps described. The attempt has been here first made to thoroughly describe the mineral resources of the state of Washington and of British Columbia. Each camp is treated separately and maps are given of the locations of the workings in each case together with such text as is necessary to indicate their importance, output, character of the ore, owners, etc.

THE GRAPHICAL SOLUTION OF HYDRAULIC PROBLEMS.—Treating of the Flow of Water Through Pipes, in Channels and Sewers, Over Weirs, etc. By Freeman C. Coffin, M. Am. Soc. C. E. New York: John Wiley & Sons. London: Chapman & Hall. Limp leather; 4½ × 7¼ ins.; pp. 75; 13 tables and 34 plates of diagrams. Price, $2.50.

This handy little volume contains diagrams for the solution of most of the problems arising in the every day practice of hydraulic engineering. The diagrams are accompanied with sufficient text and tables to explain and facilitate their use. The first 17 diagrams give the flow of water through pipes from ⅝-in. to 60 ins. in diameter, the sizes up to and including 3 ins. being included on the first diagram. The other diagrams give entry heads; value of c in $V=c\,(r\,s)^{½}$; flow over weirs, in open channels and in pipe sewers; horse power of water; size and capacity of pumps; coal required in pumping with engines of different duties; discharge of hose nozzles; and results of numerous experiments with old pipes.

There is only one diagram applicable to general sewerage work and that takes up nothing but pipe sewers. There might have been included with advantage a diagram and table or tables relating to the yield of drainage areas and the storage required under different conditions. Of course the author had to draw the line somewhere, and on the whole the selection of diagrams has been well made. The text, tables and diagrams have been well prepared by the author and the publishers have done their part in producing a very handy, pleasing and serviceable book.

AN INQUIRY AS TO A MORE PERFECT FORM OF WATER-WHEEL.—By J. P. Frizell, M. Am. Soc. C. E., Boston, 60 Congress St. Paper, 9¼×5¾ ins.; pp. 46; illustrated.

After discussing the elements entering into the working and efficiency of a perfect water-wheel, Mr. Frizell takes up the various forms of turbine wheels in use and points out what he considers their good and bad points. The author believes that the inherent and unavoidable defect of the turbine is that it cannot use a diminished quantity of water with the same efficiency as with the full quantity, that it is fitted to discharge. A wheel that shows an efficiency of 83% at full discharge generally shows not more than 65% at half-discharge. Mr. Frizell then describes several of the more prominent devices intended to lessen the loss of power from this cause; but he concludes that no existing form of wheel is free from grave, inherent and unavoidable defects, which are material at full discharge. He believes that the development of a perfect wheel requires a radical departure from existing forms; and first among these departures he would dispense with guides, as unnecessary. He believes that in a wheel surrounded by a free space sufficient to allow the water to move without restraint, it would naturally take the direction and velocity most conducive to the efficient action of the wheel and he mathematically discusses this assumption. The second essential to perfect water action is a gate that shall in closing contract not only the influx of the wheel, but the entire passage through it, and he then illustrates and describes a wheel devised by him to obviate the general existing defects and embodying the two essentials referred to above. His drawings are intended to illustrate principles only; but they cover the floats and float passages, the gate, disks, shaft, case and bearings, and regulation, and apply to wheels on horizontal or on vertical shafts.

THE DESIGNING OF DRAW SPANS.—By Charles H. Wright, M. Am. Soc. C. E., Chief of Detail and Drafting Department, Edge Moor Bridge Works; New York; John Wiley & Sons; 8vo.; cloth; pp., 90; illustrated; $2.50.

It becomes more puzzling as each new volume is added to the already extensive list of books upon bridge design to know just what position to give it in relation to other books, and to decide justly what the need for it may be among bridge engineers. In looking through the book before us a doubt arises as to the necessity of the first part treating of the general design of swing bridges, but in the second part, treating of the design of swing bridge operating machinery practically an uncultivated field has been entered. For this new departure the author deserves credit.

The method of discussion adopted is to take an 85-ft. plate girder swing span and to calculate all details of girder, floor and machinery design, and then to follow with a statement of the general formulas and assumptions upon which the preceding discussion is based. The success of the method will probably be judged differently by different engineers, according as each is more or less experienced in bridge design. It will doubtless appeal favorably to the student and young engineer, although not being of so much value to the expert bridge designer. Altogether 40 pages are devoted to general considerations of swing bridge machinery design, of which nearly one-half are given up to drawings showing examples of actual designs. None of these drawings are explained in the text, and the reader is left to his own resources to search out the faults or advantages which each may possess. A very little additional text would have improved the value of this part materially, and we can think of no good reason why the author should not have given it. In the remaining pages the space is given to the consideration of gearing, shafting, bearings, pivots, springs, cams, etc. Many of the formulas are taken from Reuleaux and Unwin, and others are the shop data of the Edge Moor Bridge Works and the Pencoyd Iron Co. No mention is made of the motors which are commonly used to operate bridge turning machinery, nor of their comparative advantages or disadvantages under different conditions of practice. Here, again, the author could, with very little work, have added valuable information. Entering as it does a new field, the book doubtless will be welcome to many from that fact alone. The publishers' work is generally good, except in the matter of illustrations, many of which are poorly drawn and lettered. The book has an adequate index.

THE MATERIALS OF CONSTRUCTION.—A Treatise for Engineers on the Strength of Engineering Materials. By J. B. Johnson, C. E., Professor of Civil Engineering in Washington University, St. Louis, Mo. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 8vo.; pp. 800; 650 illustrations, 11 plates and complete index. $6.

Prof. Johnson is well known to the readers of engineering literature as the author of works on "Theory and Practice of Surveying," "Modern Framed Structures" and "Contracts and Specifications." The present work fully sustains his reputation as one of the most painstaking and able of American engineering writers. It is a most valuable contribution to the literature of strength of materials and contains, we believe, a greater amount of new and important information on the results of experiments on materials than any other work of its kind in the English language.

The book is divided into four parts. Part I. is entitled Synopsis of the Principles of Mechanics Underlying the Laws of the Strength of Materials. It is compressed into the short space of 88 pages, and is, therefore, much briefer than the theoretical portion of other works on the subject, which are to be found in every engineer's library. Part II. describes the manufacture and general properties of the materials of construction. It occupies 215 pages. The portion devoted to methods of manufacture is very brief, as is desirable, but that devoted to general properties of materials is quite full and contains much information which is not to be found elsewhere in text books. The discussion of the properties of timber is largely derived from the author's own experiments in connection with his work for the Forestry Division of the U. S. Department of Agriculture. Part III., 160 pages, is devoted to testing machines and the methods of testing materials of construction. In this part the author has freely availed himself of the four volumes of the report of the French Commission on Standardization of Tests of the Materials of Construction, published in 1895, and of the proceedings of the five international conventions on the subject of tests of materials held in Europe between 1885 and 1895. Part IV., 360 pages, is entitled The Mechanical Properties of the Materials of Construction as Revealed by Actual Tests. The leading feature of this part is a remarkably extensive series of stress diagrams of the most significant results of tests of all kinds of structural materials, made in all parts of the world. It includes a summary of results of the series of tests of American timber, some 40,000 in number, made under the author's supervision for the work of the U. S. Forestry Division. It contains also a chapter, written by Mr. W. A. Layman, M. S., an electrical engineer, on The Magnetic Testing of Iron and Steel. Appendices contain a biographical sketch of Prof. Johann Bauschinger, the originator of the scientific testing of materials (with portrait); an account of the microscopic study of iron and steel, by Prof. J. O. Arnold, of Sheffield, Eng., with several plates; a synoptic comparison of the recommendations of the international conventions with those of the French Commission, and three sets of specifications for iron and steel for various purposes, namely: Those of the American Society of Civil Engineers, those of Mr. H. H. Campbell, author of "Structural Steel," and of the associated manufacturers of structural steel in America. Among the topics treated in the work with unusual fulness and in an original manner, besides the subject of timber, which may be called Prof. Johnson's specialty, are the Resilience of Materials, in Part I.; Lime, Cement, Mortar and Concrete, and Vitrified Paving Brick, in Part II.; Impact and Hardness Tests, and Cold-Bending and Drifting Tests in Part III.; and the Fatigue of Metals, in Part IV. The word "fatigue," commonly applied to the deterioration of metals caused by repeated and reversed loads, the author considers to be scarcely the proper term, and says "the gradual fracture of metals" would be a more truly descriptive term to all. He gives a "new and universal formula for dimensioning" for both repeated and reversed loads, designed to take the place of the two formulae of Launhardt and Weyrauch. It is

$$p = \frac{a}{1 - \frac{\text{min. stress}}{2\ \text{max. stress}}}.$$

in which p is the maximum stress per square inch in the member for both dead and live load, and a is the working stress for live loads.

The subject of the elastic limit and the yield point is discussed in a manner original with Prof. Johnson, and his conclusions are likely to create some controversy. He quotes the definitions of three different critical points or elastic limits given by the French Commission, as follows (page 306):

1. The elastic limit, or the unit stress beyond which a portion of the deformation remains as permanent set.
2. The proportional elastic limit, corresponding to the point where the deformation ceases to be proportional to the loads.
3. The apparent elastic limit, corresponding to the point where the deformations increase rapidly without any increase in the force exerted.

The author shows that no one of these three definitions of elastic limit can be used in practice, and that they are either absolutely indeterminate or wholly dependent on the delicacy of the measuring apparatus, rather than on the qualities of the material tested. When the most delicate apparatus is employed, several specimens from the same bar of the most uniform material may give elastic limits of either of the first two kinds which differ widely from each other, and hence become mutually contradictory. In other words, such delicate tests are worthless for all practical purposes, i. e., the results are not characteristic. The third definition is also indefinite since it remains a question which load is to be taken, the higher load at which the first great permanent elongation occurred, or the lower load under which this elongation continues to spread throughout the entire length of the bar. These often differ as much as from 3,000 to 6,000 lbs. per sq. in.

Discussing this subject in his preface, the author says: "The fact is, something must be done in this matter, since no one knows what is meant by elastic limit without an explanation—which explanation is not usually given."

To settle the difficulty, Professor Johnson introduces a new and arbitrary definition of what he calls the "Apparent Elastic Limit," which is "that point on the stress-diagram where the rate of deformation is 50% greater than it is at the origin." He states that in all tension stress-diagrams of the various metals it will be found to mark a well-defined point, whose co ordinates are practically fixed and constant for the same material. He supports the new definition by forcible arguments, and we quote some of his conclusions concerning it below:

Although this point is slightly beyond the true elastic limit, it will mark a point corresponding to a permanent set much less than can be measured on any scale by the naked eye, and hence it may be regarded as the true elastic limit for commercial purposes.

It serves perfectly to classify materials as to the maximum loads they can resist without receiving deformation which would injure them for continued service, these being the real "ultimate loads" for all practical purposes. It marks, therefore, the most valuable and important property of all engineering or building material. In other words, it is the most essential characteristic point on the stress-diagram.

In the opinion of the author of this work, therefore, an "apparent elastic limit," defined and determined as here described, is the best if not the only satisfactory solution of this troublesome question. The 50% increase in the rate of deformation was chosen as being about the least which would mark a well-defined point of tangency on the stress-diagram. Since it always marks a point which corresponds to an extremely small permanent set, there would seem to be no objection to its use.

We note with pleasure that Professor Johnson has followed Professor Merriman's latest work on strength of materials in eliminating the word strain as synonymous with elongation, distortion or deformation, although he thus used it in his earlier works. He uses the word "deformation" instead. In this he is in harmony with the opinion which has been repeatedly expressed by us editorially. He says: "The word 'strain' is used in common language in several other senses, so that its use in this specific sense, though warranted, is of doubtful propriety."

The typography and most of the illustrations in the book are excellent, but the appearance of the numerous stress-diagrams might have been greatly improved if their lettering had been more carefully done, and if lower-case letters had been used rather than capitals. We congratulate the author and the publishers on the production of a book which much long remain a standard in American engineering literature. The price, $6, is unusually low, considering the labor and expense which must have been devoted to its preparation.